Empirical Essays in Experimental and Labour Economics

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To our daughters Agnes and Matilda, you make me work harder.

To God be the glory.

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Preface

This dissertation consists of four independent research papers. All four papers include their own abstracts, introductions, references, and appendices, and can be read individually.

The first paper of this dissertation (co-authored with Prof Manfred Königstein) is titled "Comparing Capitalism and Socialism: A Laboratory Experiment". In this paper we compare a capitalist and socialist market in a laboratory experiment. The laboratory experiment permits an ideal comparison of socialism and capitalism because everything except the market institution is kept the same. This is not possible when looking at real-existing market systems. In spite of the decline of real-existing socialist regimes many people still think socialism could be an efficient economy system. Socialism can be thought of as a market institution with intervention by the government and/or inflexibility of prices. There are different forms of socialism ranging from command socialism where by buyers receive goods and sellers produce goods according to what the political authority mandates, to socialism that is basically a free market economy with a social transfer system. Our socialist market is in between. In our socialist market, a pricing committee which is representative of the market participants decides on the price of a good. Consumers and producers decide freely about demand and supply at the fixed price. Since prices cannot freely adjust to equate supply and demand, a rationing scheme is applied when there is under- or over-supply. In the laboratory the capitalist market is implemented as a double auction market. Studies have shown that double auction markets are efficient and prices quickly converge to the theoretical competitive equilibrium price. This makes the double auction market a good market for which our socialist market can be compared to. We find that the socialist market reaches only about 75% efficiency whereas the capitalist market is near 100%. In addition, results show that the socialist market is good for consumers when welfare losses due to rationing are ignored.

Paper 2 titled "Improving Efficiency in Socialism: A Laboratory Experiment" investigates the effect, political bias in the price-setting committee of a socialist market, has on market efficiency. In this study, the market efficiency of a socialist market is investigated under three treatments. In the socialist market, a price-setting committee decides on the price of a good. Consumers and producers are informed of the price, and they can decide freely about demand and supply at that price. In case of under- or over- supply, a rationing scheme is implemented. In a capitalist market, prices are controlled by market forces. These prices communicate

information about scarcity and abundance. For example in a market economy, consumers know that when the price of a good is high, that signals scarcity, and when the market price is low, it signals abundance. With these information consumers can act accordingly. On the other hand, in a socialist economy where prices are set by a central authority, the information transmitted by the set prices are false. The main reason for the failure of socialist economy systems is the manner in which prices are determined. Does the price decision become better if the price-setting committee is representative of the entire population? Would a committee that is representative of the population seek the interest of the entire society instead of their own political agenda? In the first treatment the price-setting committee is representative of the entire population (sellers and three types of buyers). In the second treatment the price-setting committee consist of sellers and high-value buyers. In the third treatment the price-setting committee consist of only buyers (low- and intermediate-value buyers). The findings indicate that bias in the constitution of the price-setting committee affects trade price and profit distribution, but has no effect on efficiency and trade quantity.

Paper 3 is titled “Female Labour Force Participation in Urban and Rural Cameroon: An Empirical Study”. Female labour force participation (FLFP) is a good indicator of the status of women in a society. A woman´s participation in the labour force does not only offer monetary gains, but can also empower her and her female children. The aim of this study is to determine the factors that influences female labour force participation in Cameroon. This paper is motivated by the fact that, although there has been a huge number of studies done on the determinants of FLFP worldwide, to the best of my knowledge, only two has been done in Cameroon. Binomial logit regression analysis revealed that some of the statistically significant determinants of FLFP in urban and rural Cameroon are age, number of children in the household ages 5 and under, and region of residency. Marital status was also a key predictor in rural, but not urban Cameroon. One striking result was that although not significant, educational attainment level was negatively related to FLFP. The results also reveal that there is an urban/rural residency gap in FLFP. To explore this further I employ a decomposition analysis. The decomposition analysis reveals that only 36% of this difference is accounted for by differences in the characteristics of women in the urban compared to their counterparts in the rural areas. Finally using DHS data, I give a brief overview of the trends in female and male labour force participation in Cameroon between 1998 and 2011. I find that while the labour force participation of women between the ages of 15-19 decreased between 1998 and 2011,

those ages 45-49 increased. Also female labour force participation in urban Cameroon increased between 1998 and 2011.

Paper 4 titled “Is Sibling Gender Composition a Good Instrumental Variable for Fertility in Cameroon?” seeks to determine if sibling gender composition is a good instrument for fertility in Cameroon. Studying the relationship between fertility (the number of children a woman has) and her participation in the labour market is complicated by the endogeneity of fertility. To solve this problem, researchers have successfully used several instrumental variables as a source of exogenous variation in fertility. One of those instruments is the gender of a woman´s first two children. This instrumental variable is based on the fact that parents prefer to have a mixed gender composition of children and the gender composition of children is a random occurrence. The result of this study shows that sibling gender composition is a poor instrument for fertility in Cameroon.

PAPER 1:

Comparing Capitalism and Socialism – A Lab Experiment

Abstract

Despite the historic failure of real-existing socialism the political vision of socialism is still alive and raises the question whether a democratic and economically successful socialism is possible. We believe that the answer is “No”, and we provide empirical support for our view. We show that there are inherent forces that drive socialism to weak economic performance. In a lab experiment, we compare the same market structure under two different institutions, a capitalist market and a socialist market. The former is implemented as a double auction, the latter as a market where a representative committee sets the trading price by democratic vote and then buyers and sellers deciding freely on demand and supply thereafter. If aggregate demand and supply do not match, the longer market side is randomly rationed. We show that the socialist market reaches only about 75% efficiency whereas the capitalist market is near 100%. The socialist market is good for consumers but only if welfare losses due to rationing are ignored.

1. Introduction

Despite the historic failure of real-existing socialism the political vision of socialism is still alive. Movements against international trade agreements, global pollution and depletion of natural resources or against globalization in general have revived socialist ideas. And even mainstream political parties like the social democratic party in Germany still refer to democratic socialism as a long-run goal for society. More than 25 years after the wall was torn down in Germany memories of the 40 years socialist period are fading leading to doubts regarding strengths and weaknesses of the former system: Maybe it performed weakly because of bad political leadership and bad economic management? Maybe it was undemocratic because of a ruling totalitarian group? Maybe a democratic and economically successful socialism is possible? – We believe that the answer to the latter question is "No", and we provide empirical support for our view. We show that there are inherent forces that drive socialism to weak economic performance.

In a laboratory market experiment, we compare two ways of organizing an economy (two market institutions), a socialist market and a capitalist market. The socialist market features a central authority fixing the price at which a good may be traded between producers and consumers. The price is set by majority vote and the central authority (we refer to it as the "pricing committee") is representative of society; so it is truly democratic. Consumers and producers decide freely how many goods to buy/sell at the given price. In contrast, the capitalist market allows consumers and producers to determine price and trade quantity freely. It is organized as a double auction allowing trading at varying prices. The lab experiment implements an ideal comparison of socialism and capitalism in the sense that everything is kept the same except the market institution. Such ceteris paribus comparisons are infeasible when looking at real-existing economic systems.

One may, of course, have a different view on how a socialist market should be modelled. Political ideas of socialism vary from rather liberal ones considering basically a free market economy with a social transfer system to extreme versions where the state allocates everything. Our socialist market is in between. The trading price of goods is fixed by a central authority. Consumers and producers decide freely about demand and supply at the fixed price. That prices are set by central authorities is common in real-existing socialist societies. Firms deciding freely about supply is less common. Thus our experimental market is less strongly

regulated than markets in socialist societies. It can be seen as a cautious test regarding the efficiency of socialist markets.

Our main result is that the socialist market performs rather weakly compared to the capitalist market. While the latter reaches an efficiency of almost 100% the former is at about 75%. A reduction of about 25 percentage points is huge relative to standards e.g. in measuring GDP. In the capitalist market, we find a reduction in price dispersion over time and a trend toward the competitive equilibrium price level. In the socialist market, there is no reduction in price dispersion and no clear trend but the price is lower than the competitive equilibrium level. Low prices are good for consumers in the sense that many consumers can afford to buy a good. However, low prices reduce the ability of producers to sell without making a loss. So the offered quantity is low. Accordingly, the socialist market in the lab reproduces the failure of real-existing socialism: Too low prices induce too low quantity leading to rationing of consumers and overall welfare loss compared to a capitalist free-market system. There is a reservation with respect to distributional issues: If one ignores producer surplus, one may like the socialist market since it increases consumer surplus. However, if one takes also a consumer surplus loss due to rationing into account even this distributional advantage is lost. The rest of the paper is organized as follows: Section 2 discusses related literature, section 3 describes the experimental markets in detail and section 4 provides experimental procedures. The data analyses are contained in section 5. Section 6 summarizes and concludes.

2. Literature

2.1. Laboratory Markets

In Economics, a market institution is the trading rules and mechanisms governing economic exchanges. Laboratory markets allow researchers to evaluate the performance of market institutions in a controlled environment. It can be used to study why certain institutions fail in real life economy. In a laboratory experiment institutional rules and other environmental features[1] must be specified (Davis & Holt, 1993 p.33). Chamberlin (1948) published the first market experiment[2]. His experiment was on the competitive market theory. According to neoclassical competitive market theory, the quantity buyers' demand of a good is negatively related to the price of the good, whereas the quantity supplied by sellers is positively related

[1]Environmental features are the structural characteristics such as number of experimental participants. endowments, initial information and so on, of a laboratory experiment (Davis and Holt, 1993 p. 33)
[2]See Roth (1995 p.4-21) for a review on the history of experimental economics.

to the price of the good. The competitive equilibrium price is the price at which quantity supplied is equal to quantity demanded. The corresponding quantity is referred to as competitive equilibrium quantity. In Chamberlin´s study, the participants who were buyers received their demand price which was the maximum amount the person would be willing to pay to purchase the good. On the other hand, sellers received supply prices which were the minimum price the person would be willing to sell the good. Each participant´s supply or demand price was only known to them. The participants were allowed to move around the room and negotiate contracts. His findings were not consistent with that predicted by the competitive theory. He found trade quantity to be higher and trade price lower than the competitive equilibrium.

In 1962, Smith, who was one of the participants in Chamberlin´s market experiment, improved Chamberlin´s one shot decentralized negotiation. Firstly, instead of letting participants move around the room and negotiate contracts, sellers/buyers asks/bid prices were public information. Also, in contrast to Chamberlin's market that lasted for only one trading period, Smith allowed subjects to trade in several trading periods with the same supply and demand structure (Smith, 1962). He stated that with several periods, participants will gain some experience and as a result, there is a possibility of competitive equilibrium being attained. Smith´s market organization, known as a double auction market, validated the competitive market theory.

2.2. Laboratory Trading Institutions

Before running an experiment the rules governing trade must be decided on. Trading institution range from two-person bargaining games, with a single price offer and a yes or no response, to complex double auction markets (Holt, 1995). In this subsection, we briefly discuss the double auction and the posted offer trading institutions. In our experiments, we use the former to implement the capitalist market and the latter is similar to the trading institution we use as the socialist market.[3]

[3]See Holt (1995) for a review of the commonly used trading institutions.

2.2.1. Double Auction Market

In this institution buyers and sellers are allowed to submit bid and ask prices respectively. Bid and ask prices are visible to all participants. Sellers must submit a lower ask price than the current lowest ask price and buyers must submit a bid that is higher than the current highest bid price. Thus ask prices falls and bid prices rise. A unit is traded when a buyer/ seller accepts a seller´s/buyer´s offer. Any buyer (seller) is free to accept any seller´s offer (buyer´s bid) displayed in the ask/bid queue. Double auction trading rules are similar to those used in securities markets (Davis & Holt, 1993). Since Smith (1962) showed experimental evidence to support convergence to theoretical competitive equilibrium under a double auction market, many other studies have confirmed this. The double auction markets tend to result in efficient, competitive equilibrium outcomes under a wide range of market settings, sometimes even in a monopoly (Davis and Holt, 1993, chapter 3).[4]

2.2.2. Posted-Offer Market

In a posted offer institution each seller decides on a price and the maximum quantity they are offering at that price. The price, but not the quantity is shown to both the buyers and the other sellers. After all sellers price has been posted, one at a time each buyer is selected randomly and is given the opportunity to decide which price he wants to purchase the good at and how many units. Trading ends when all buyers have had an opportunity to buy (see Davis & Holt, 1993 p 175). Buyers tend to choose sellers with lower prices. When the roles of buyers and sellers are reserved, the market is known as a posted bid market. The posted bid market is mostly met in cases where there is only one seller (Holt, 1995).

2.3. Capitalism vs Socialism

According to the invisible hand theory proposed by Adam Smith (1776), in an unregulated market where consumers are allowed to choose freely what to buy and producers are allowed to choose freely what to sell and how to produce it, consumers demand for a good will be equal to producers supply of that same good and the market will settle on a product distribution and price that are beneficial to the society and thus efficient. Smith´s proposal was the foundation of the capitalist thought (Bradley, 2009 p. 20). Capitalism is a market system based on private ownership of the means of production. On the other hand, Socialism

[4]See Friedman (1993) for a survey of the experimental research on the double auction.

is a market system whereby firms are owned and controlled by the government.[5] In this study, we compare the capitalist and the socialist market. Comparing market institutions has been done in the past.[6] Since markets implemented as double auction generates competitive outcome quicker than markets under any other trading institution, double auction markets have been frequently used as a standard by which the performance of other institutions are assessed (Davis & Holt, 1993).

3. Experimental Design

3.1. Market Structure

Both market institutions, the socialist market and the capitalist market, rely on the same market structure, i.e. the same number of buyers and sellers and the same distribution of buyer valuations and seller costs. The induced value mechanism suggested by Smith (1976) was used to create demand and supply in both markets. There are six buyers, two for each of three buyer types (low, mid and high valuation) and two symmetric sellers. Each buyer may buy up to four units of a fictitious good. Buyer valuations for each unit bought are shown in Table 1. In the experiment, if a buyer bought a unit, she/he earns a monetary payment equal to the displayed valuation minus the trading price.[7] This induces monetary trading incentives. Similarly, if a seller sold a unit, she/he earns a payment equal to trading price minus cost. Cost schedules are shown in Table 2. Each seller may sell up to 15 units. The market runs over 15 periods with the same structure and institution in each period.

3.2. Capitalist Market Institution

The capitalist market is organized as a double auction. Buyers can freely submit bid prices which are collected in an ascending bid price queue. Sellers can freely submit ask prices which are collected in a descending ask price queue. A trade is closed if a buyer accepts a seller's ask or if a seller accepts a buyer's bid. Then all previous bids and asks by this pair of traders are erased from the respective queues and trading continues. Since buyer valuations decline and seller unit cost increase, some point will be reached where trading stops and the period ends.

[5]For a detailed discussion on capitalism vs socialism, see Chavance, B (2003).
[6]For studies on comparisons of trading institutions, see Plott and Smith (1978); Smith et al.,1982 ;Ketcham et al.,1984; Davis and Williams, 1986; Cason and Williams (1990).
[7]This is a usual procedure in experimental market research (see Smith 1962).

In the experiment, there was sufficient trading time before closing a period and starting a next one.

Table 1
Buyers' valuations

Units	1	2	3	4
Buyer 1	100	100	80	60
Buyer 2	100	100	80	60
Buyer 3	100	80	80	60
Buyer 4	100	80	80	60
Buyer 5	100	80	60	60
Buyer 6	100	80	60	60

Values are in experimental currencies

Table 2
Sellers' costs schedule

Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Seller 1	10	10	10	10	10	30	30	30	30	30	70	70	70	70	70
Seller 2	10	10	10	10	10	30	30	30	30	30	70	70	70	70	70

Costs are in experimental currencies

3.3. Socialist Market Institution

Trading in the socialist market happens in two steps. First, a pricing committee decides on a fixed trading price. The committee comprises four members, one buyer of each type and one seller. Committee members may sequentially suggest prices. The first price that is suggested by two members is the effective trading price for that period. This price is then announced to all buyers and sellers. Each buyer (seller) submits individual demand (supply). If aggregate demand and supply match, all trades are executed; if not, the longer market side is rationed randomly to match the shorter side.[8] This closes the period and starts the next one.

[8] In case of undersupply buyers are rationed (buying orders are cut at random to equate to supply) and in case of oversupply, sellers are rationed (selling orders are cut at random to equate demand).

3.4. Theoretical Benchmark Solutions

The market features only four buyers and two sellers who, in principle, could be able to exercise market power. Nevertheless, we can calculate the competitive market equilibrium as a benchmark solution to which we can later compare observed market outcomes. Figure 1 shows the aggregate market demand and supply curve. The value and cost structures of the four buyers and two sellers determine the aggregate market demand and supply function and thus, the theoretical competitive equilibrium. The price and quantity at which the demand and supply curve intersect is the equilibrium price and quantity respectively. The equilibrium (and welfare-maximizing) price is 60, the equilibrium (and efficient) quantity is 20. Buyers' values and sellers´ costs are also used to determine the possible total welfare (the area between the induced aggregate market supply and demand curve). Total welfare is 1280 comprising a consumer surplus of 480 and a producer surplus of 800. The competitive equilibrium assumes individually rational behaviour. This is a natural assumption for the capitalist market.

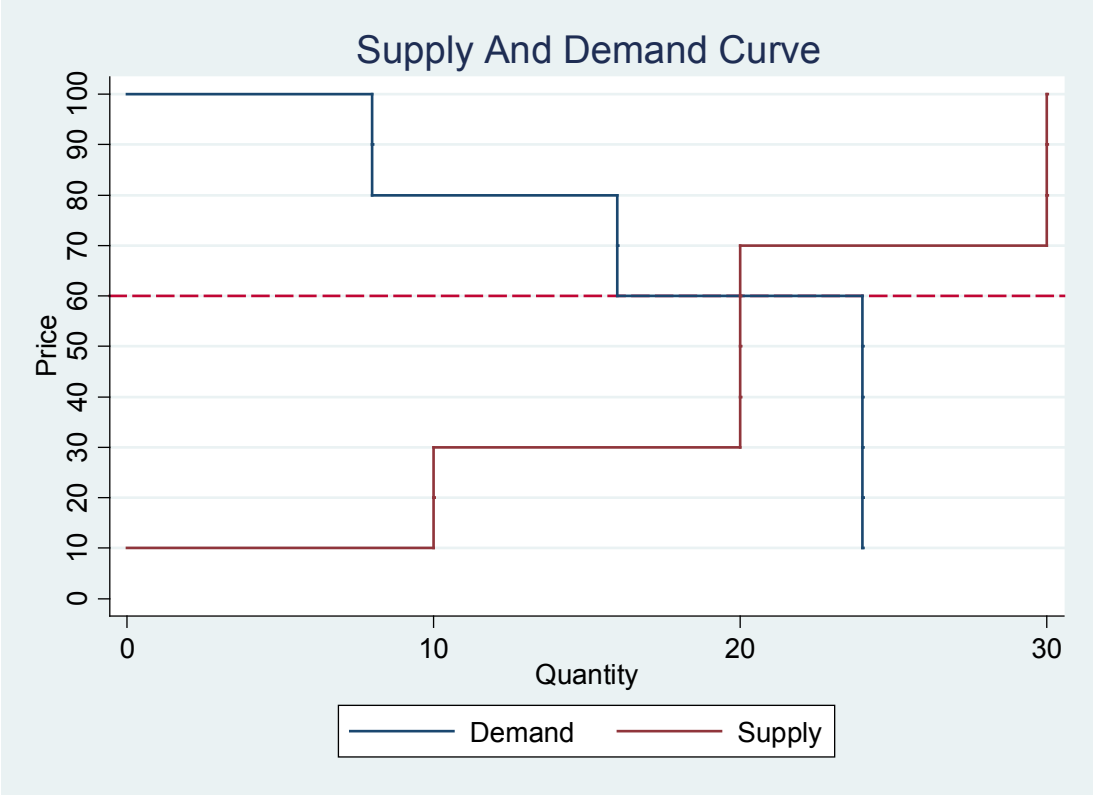
In the socialist market, we should distinguish between individual traders, for which one may assume individual rationality as a benchmark assumption, and the pricing committee. The committee decides collectively by majority vote. A natural benchmark assumption is a collective rationality, i.e., the committee seeks to maximize welfare. This may lead to the same result as the competitive equilibrium. However, the efficient quantity could also be traded at a price of 30 inducing a consumer surplus of 1080 and a producer surplus of 200. Furthermore, relying on individual rationality two committee members could form a coalition to implement a price that maximizes the coalition's payoff. Since there is only one seller but three buyers in the committee, a buyer coalition is plausible. This will also induce a price below 60. Besides these considerations of rational choice there are clear political-economic viewpoints on the performance of capitalism and socialism which we summarize in two hypotheses:

Capitalist Market Hypothesis: The capitalist market induces a competitive price and an efficient allocation.

Socialist Market Hypothesis: The socialist market induces an efficient allocation at a price that is as low as possible.

Both hypotheses describe idealized cases. Inefficiency should be avoided in any economic system. A low price is perceived as consumer friendly, therefore a low-price policy is plausible for socialism. The lowest price allowing for an efficient allocation is 30. These are two general hypotheses regarding a capitalist and respectively a socialist market. We will derive more specific and statistically testable hypotheses below.

Figure 1
Induced aggregate market supply and demand curve



4. Experimental Procedure

The experiments were carried out in the ERFURTER LABORATORIUM FÜR EXPERIMENTELLE WIRTSCHAFTSFORSCHUNG (eLab), Erfurt, Germany (in German) and participants were recruited using the software package ORSEE (Greiner, 2004). The experiment was programmed using the software program z-tree (Fischbacher, 2007)[9]. To make sure the rules of the experiment were understood, subjects received written instructions before the experiment began. They were also given some time to ask clarifying questions concerning the experiment privately. Written instructions pertaining to both treatments are attached to Appendix A and B. The instructions in the appendix have been translated from German into

[9] Codes can be provided upon request.

English. In the laboratory, participants sat in separate cabins and they were identified only by a number. Privacy and anonymity was implemented to minimized subject bias in the experimental market. A total of twelve experimental sessions were conducted for each market institution. Each subject participated in only one session and acted as either a buyer or a seller. In each session, there were six buyers and two sellers. Subjects were randomly assigned the role of a buyer or a seller.

Each experimental session consisted of two trial (non-paid) periods and fifteen trading periods each lasting 2 minutes. Results of the two trial periods were excluded from analysis. Each trading period represents a market day. Buyers/sellers were given a list of units and their corresponding unit values/costs. A unit value is the maximum price a buyer is willing to pay for that unit of the commodity whereas a unit cost is the minimum price a seller is willing to sell that unit of the commodity. These values and costs were the same in all the trading periods. Traders had no information about the unit values and costs of other traders. Profit was only made if a unit was sold, in which case the buyer earned the difference between the unit valuation of the traded commodity and the price at which it was traded. Sellers' profits were the difference between the price and the unit cost of the traded commodity. Individual profits were calculated and displayed on the individual´s computer screen after each trading period. Profit was displayed in terms of experimental currency, which was converted into euros at the rate of 1000experimental currency = €3. Accumulated profits were paid in cash at the end of each experimental session. Participants also received a show-up fee of €4 in addition to their earnings.

5. Data Analysis

5.1. Examples of Received Data

Figure 1 above illustrates the theoretical market structure. It shows aggregate demand and supply as well as the competitive equilibrium exhibiting a price of 60 and a quantity of 20. Figure 2.a shows the observed trade prices for one capitalist (CAP) session. Each dot represents a single trade, e.g., in period 1 the first trade occurred at a price of 90, the second trade at price of 65 and so on. Figure 2.a is typical for double auction experiments. It indicates a declining price dispersion over time and a movement of prices toward the competitive equilibrium price. As the trading period increases, the variation in trade prices declines and cluster more closely around the competitive equilibrium. Figure 2.b illustrates the observed

prices and traded quantity, for a single socialist (SOC) session. The price is the same for all trades within a period since there is a single price set by the committee. One can see that price and quantity vary over periods with no obvious trend. While Figures 2.a and 2.b serve to illustrate the data of single sessions our analysis below will be based on session-aggregates. Importantly since individual decisions within sessions are correlated our statistical tests will use sessions as units of analysis, unless stated otherwise.

Figure 2.a
Observed trade prices of one CAP session

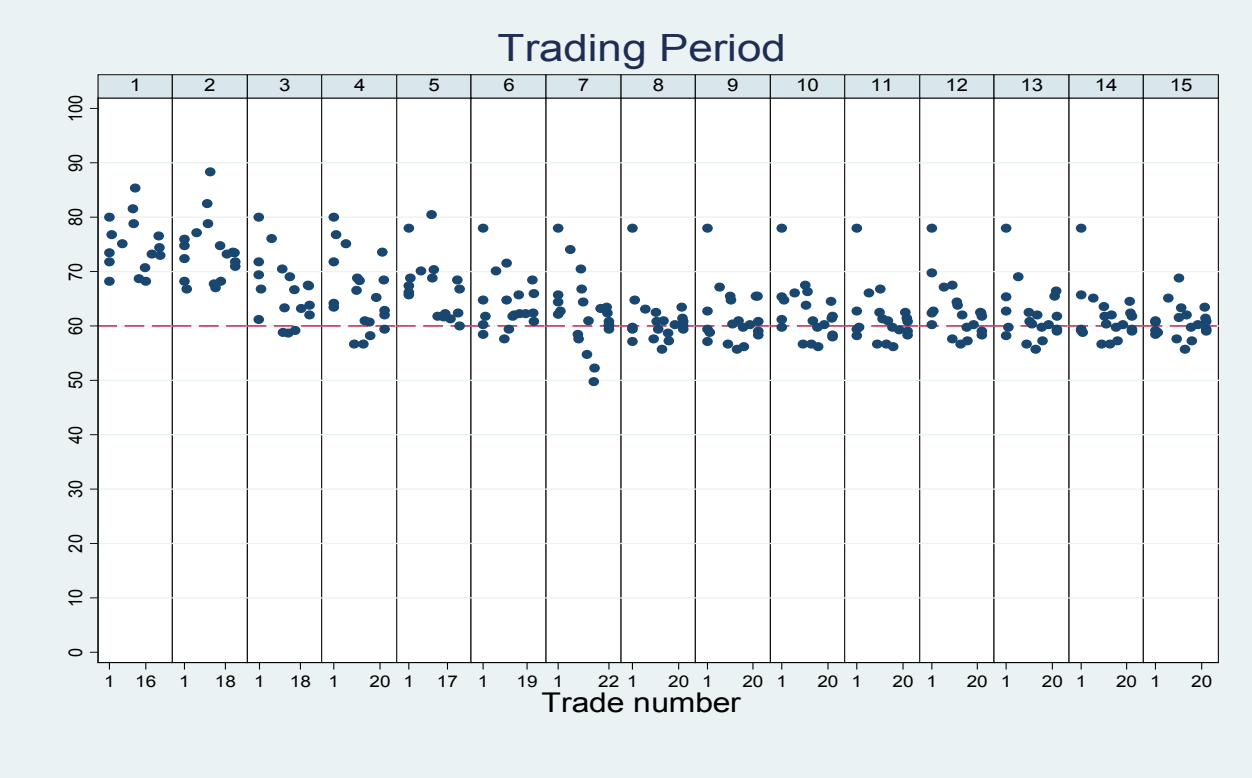
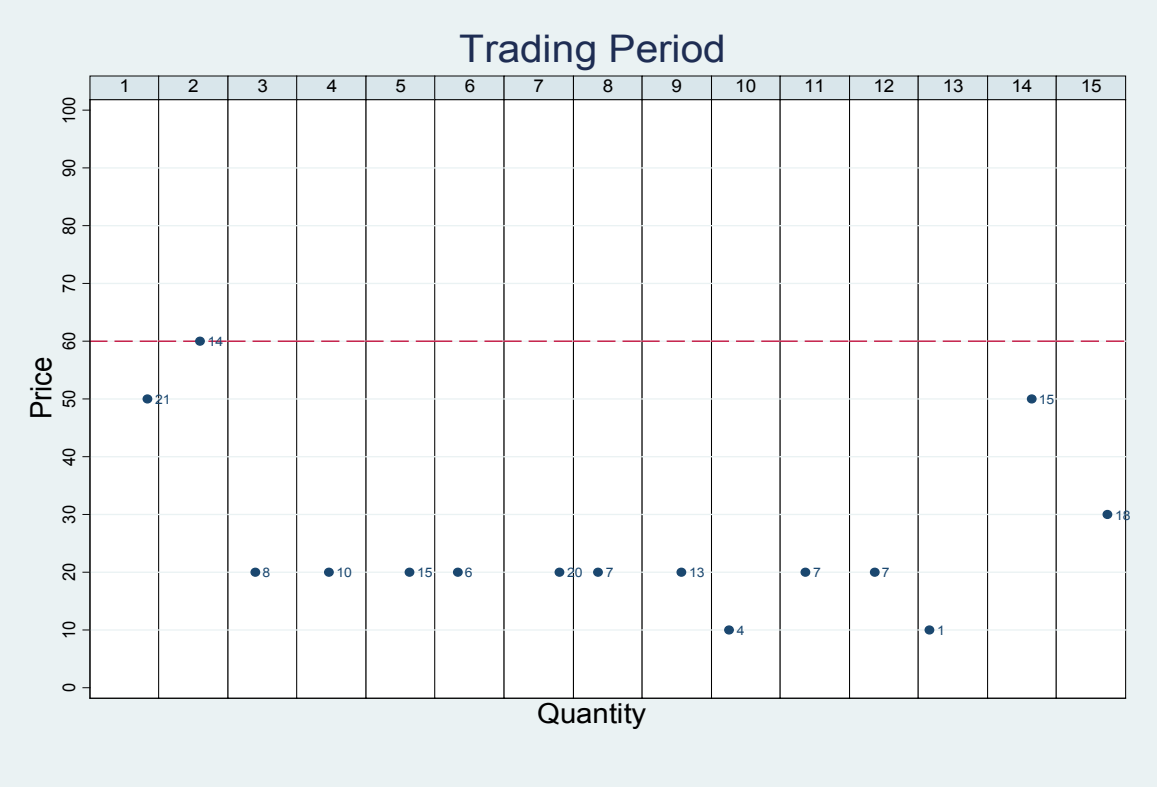


Figure 2.b
Observed trade prices and corresponding quantities of one SOC session



5.2. Price Convergence

Other experiments on market experiments, especially on double auctions, have shown that price dispersion reduces over time and that the average transaction price converges to the competitive equilibrium. We analyze whether this holds in our experiment as well. In treatment CAP competitive market theory predicts p = 60. Allowing for learning one should expect prices to vary but the variance should decline over time. Since there are only two sellers in the market, in principle, they might be able to exercise market power. In this case, the price should be above the competitive level. In SOC one might expect the price to converge to some level between 30 and 60 since this price range is consistent with efficiency. Consumers have a majority in the price-setting committee. They might be able to use this political power (majority power) to implement a low price which is beneficial for consumers at the expense of producers. The lowest price consistent with an efficient allocation is p = 30. Figures 3.a and 3.b show time-series plots of the mean (per period) trade prices for both treatments and all sessions. Each line represents a single session. For CAP (Figure 3.a) we see a convergence toward the competitive equilibrium and welfare maximizing price p = 60 (reference line). For

SOC (Figure 3.b) this is not the case. Price dispersion even seems to increase over time. The mean price has no clear trend but it is definitely lower than p = 60.

Figure 3.a
Time path of mean trade prices for the 12 sessions of the CAP market across trading periods

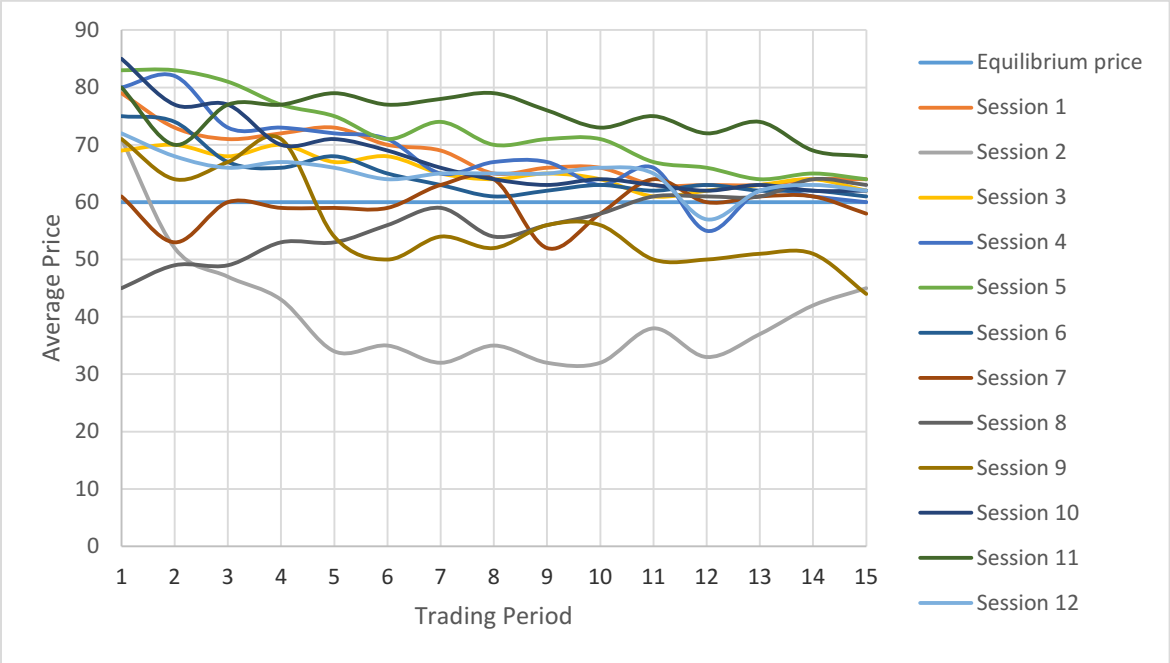
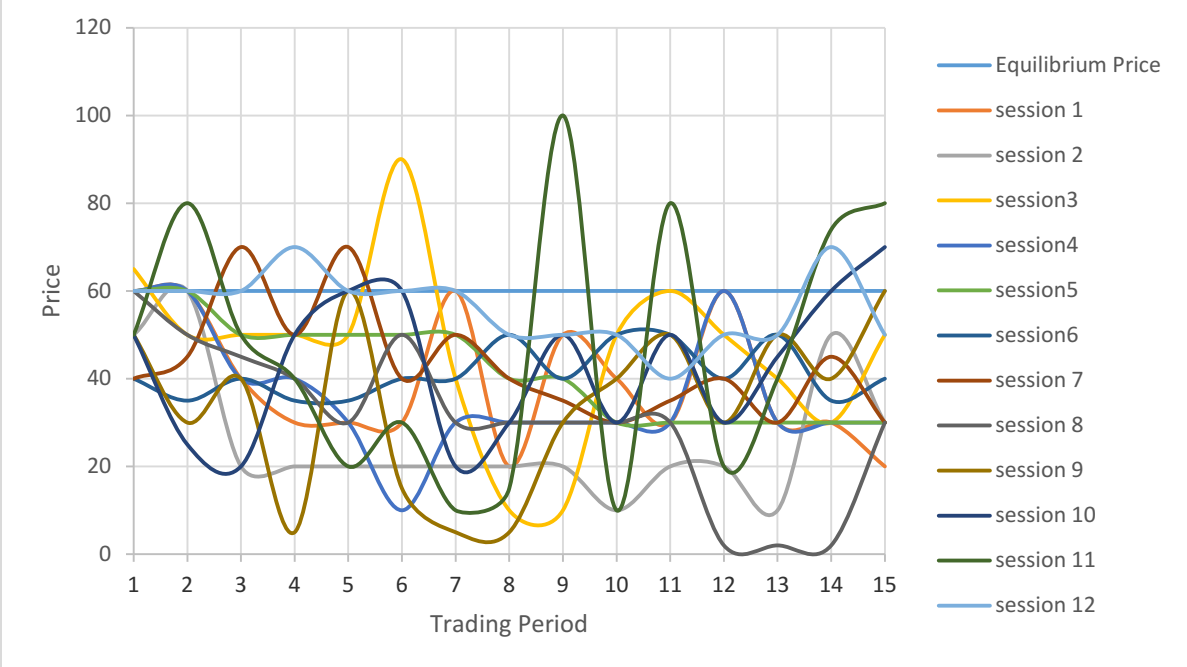


Figure 3.b
Time path of trade prices for the 12 sessions of the SOC market across trading periods



Hypothesis 1. Reduction of Price Dispersion: The coefficient of variation of mean (per period) trade prices declines over periods!

To test this hypothesis we compute the coefficient of variation (standard deviation/mean) of the mean trade price over periods 1 to 7 as well as 9 to 15 for each session separately.[10] For CAP the coefficient of variation reduces on average to about 63.7% (median: 60.6%). It reduces in 11 out of 12 sessions. The reduction is highly significant (Wilcoxon Matched Pairs Test, N = 12, p = 0.006).[11] For SOC the coefficient of variation increases on average to about 136.8% (median: 106.7%). The Null-Hypothesis cannot be rejected (Wilcoxon Matched Pairs Test, N=12, p = 0.814). We conclude that there is a significant reduction of price dispersion in CAP but not in SOC.

Next, we investigate price convergence according to the convergence coefficient α^2 as introduces by Smith (1962)[12].

Hypothesis 2. Convergence to Competitive Equilibrium Price in CAP: The trade price in CAP converges to the competitive equilibrium level according to the criterion of Smith (1962).

Computing the convergence coefficient we find that it is declining over time. Calculating averages of α^2 for periods 1 to 7 versus periods 9 to 15 and applying a Wilcoxon Matched Pairs test using sessions as units of analysis (N = 12) we can reject the Null-Hypothesis (p = 0.008). Thus, convergence is highly statistically significant. A closer look reveals that in periods 9 to 15 α^2 is reduced to 46.6% (on average) of the according value for periods 1 to 7. So the reduction in variance around the competitive equilibrium is rather substantial.

For treatment SOC we did not find a price convergence (Hypothesis 1), so it makes no sense to investigate the more specific question of convergence to p = 60 or p = 30. Nevertheless, we can apply a regression approach that has been proposed by Ashenfelter et al. (1992) and has been used for market experiments by Noussair et al. (1995, 1997) to estimate long-run asymptotic behaviour. We do this together for both, CAP and SOC, in the following regression model:

[10]Here and later on we calculate statistics separately for early and later periods since participants may learn during the experiment. In general we are especially interested in experienced behavior.

[11]Unless explicitly stated otherwise all reported p-values refer to two-tailed tests.

[12] The coefficient of convergence is: $\alpha^2 = \frac{1}{n}\sum_i^n (p_i - p^*)^2$ withp_i representing a single observed trade price and p^* representing the competitive equilibrium price. So α^2measures the variance around the equilibrium price.

$$p = \alpha_1 \cdot T1_{CAP} + \alpha_2 \cdot T2_{CAP} + \beta_1 \cdot T1_{SOC} + \beta_2 \cdot T2_{SOC}$$

with p representing the observed mean (per period) trade price, and$\alpha_1, \alpha_2, \beta_1$ and β_2 being the estimated coefficients. The explanatory variables are defined as follows:

$$T1_{CAP} = \begin{cases} \frac{1}{t} & \text{if treatment CAP} \\ 0 & \text{if treatment SOC} \end{cases} \qquad T2_{CAP} = \begin{cases} \frac{t-1}{t} & \text{if treatment CAP} \\ 0 & \text{if treatment SOC} \end{cases}$$

$$T1_{SOC} = \begin{cases} \frac{1}{t} & \text{if treatment SOC} \\ 0 & \text{if treatment CAP} \end{cases} \qquad T2_{SOC} = \begin{cases} \frac{t-1}{t} & \text{if treatment SOC} \\ 0 & \text{if treatment CAP} \end{cases}$$

with t = 1, 2, …, 15 representing the period index. Thus, α_1 is the origin and α_2 is the asymptote of a possible convergence process for treatment CAP. Similarly, β_1 and β_2 are the origin and asymptote of a possible convergence process for treatment SOC. The results of robust OLS regressions adjusting for clustering on sessions are presented in Table 3**.**

Table 3
Regression Estimates from the Ashenfelter-El-Gamal regression model

Coefficient	**CAP**	**SOC**
α_1	74.21***	
α_2	60.05***	
ß$_1$		55.95***
ß$_2$		36.00***
H_0: α_2= 60	F =0.00	
H_0 : ß$_2$= 60		F = 63.85***
H_0 : α_2= ß$_2$	F = 32.91***	F = 32.91***

***** p<0.01, ** p<0.05, * p<0.1**

Accordingly, in CAP (SOC) mean price starts at 74.21 (55.95) and asymptotically approaches 60.05 (36.00). So there is almost perfect convergence to the competitive equilibrium and welfare maximizing price in CAP. In SOC the estimated asymptotic price is in the range [30, 60] which allows for efficiency. In addition to the usual coefficient tests, we report tests for whether or not the asymptotic prices differ between treatments (“yes”) and differs from 60 (“yes” for SOC, “no” for CAP). Asymptotic behaviour is more important to us than initial play. We are more interested in stable behavioural patterns after participants have learned to avoid

mistakes that naturally occur more likely in the beginning of an experiment.[13] We summarize our findings on trade prices as follows:

Result 1: In CAP price dispersion declines over time and the average trade price converges to the competitive equilibrium price. In SOC there is no significant reduction in price dispersion over time. The average trade price drives away from the competitive equilibrium price.

While the first part is a replication result for double auction experiments, this should not be expected necessarily since in our experiment there are only two sellers. So exercising market power could not be excluded from the start. The convergence is, however, rather impressive in our view. On the other hand, the non-convergence in SOC is also very interesting and the price reduction compared to CAP is rather substantial.

5.3. Traded Quantity and Market Efficiency

The analysis of quantity and market efficiency are closely related since efficiency depends on the number of goods traded as well as on the reservation values and cost values of the traded goods. Furthermore, efficiency is a normalized measure. Therefore we focus primarily on efficiency. Efficiency measures the gains from trade, we also refer to it as social surplus. In the experiment social surplus is the same as total payoff received by consumers and producers, since consumer surplus is also paid in cash. Our main hypothesis regarding market efficiency is as follows:

Hypothesis 3: Social surplus is higher in CAP than in SOC!

Time paths of quantity and efficiency are displayed in Figures 4.a, 4.b, 5.a and 5.b.

[13] Similar to Noussair et. al (1995, 1997) we also estimated an alternative model (not reported) allowing for session-specific T1-effects. The estimated T1-coefficients differ between sessions, however, this does not influence the T2-results.

Figure 4.a
Time path of trade quantity for the 12 sessions of the CAP market across trading periods

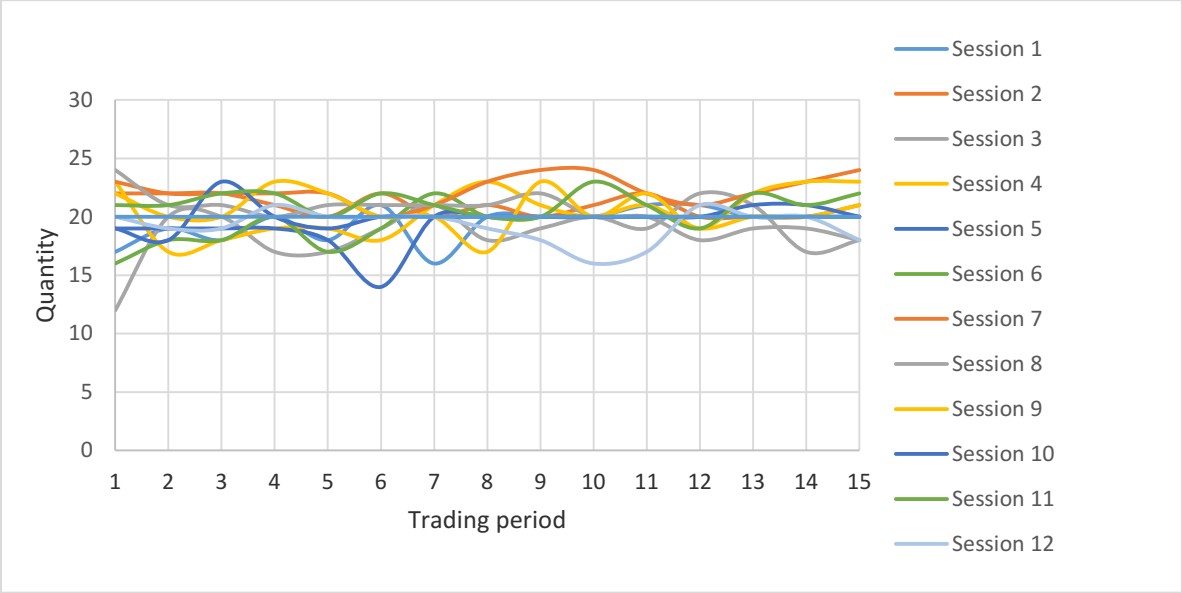


Figure 4.b
Time path of trade quantity for the 12 sessions of the SOC market across trading periods

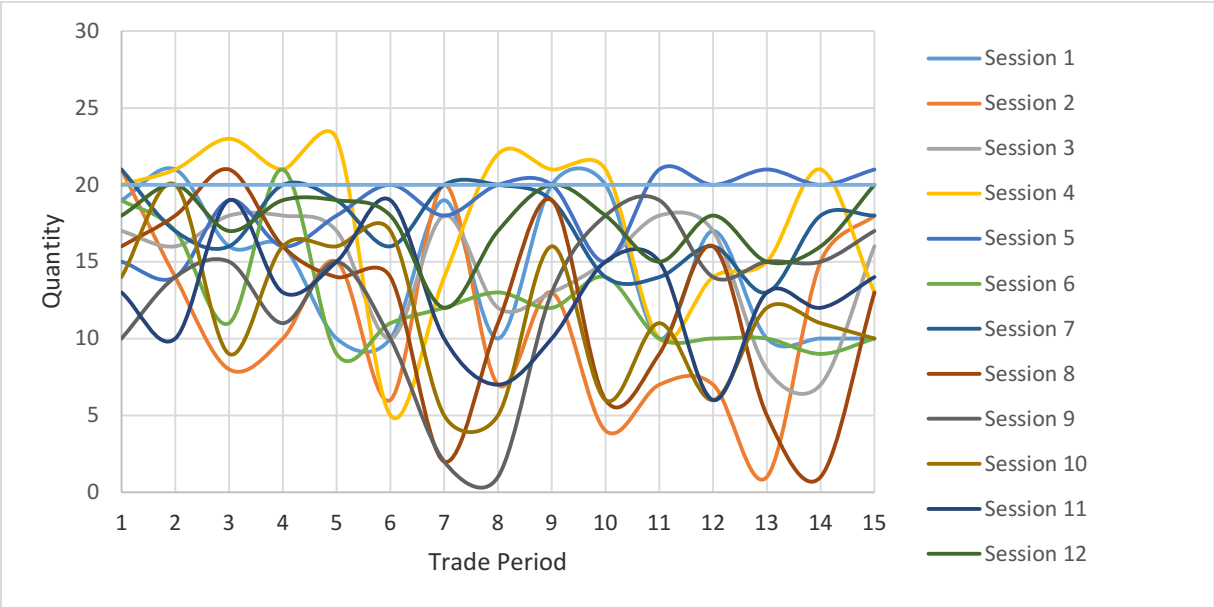


Figure 5.a
Market efficiency of the 12 sessions of the CAP market across trading periods

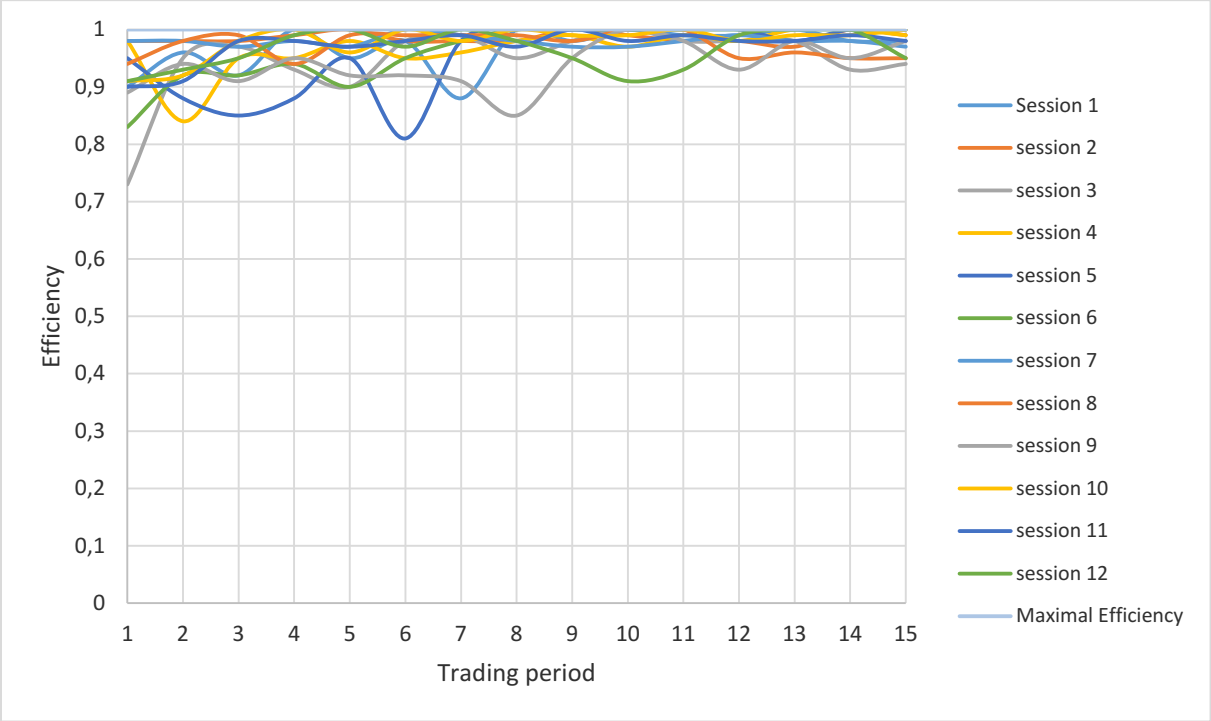
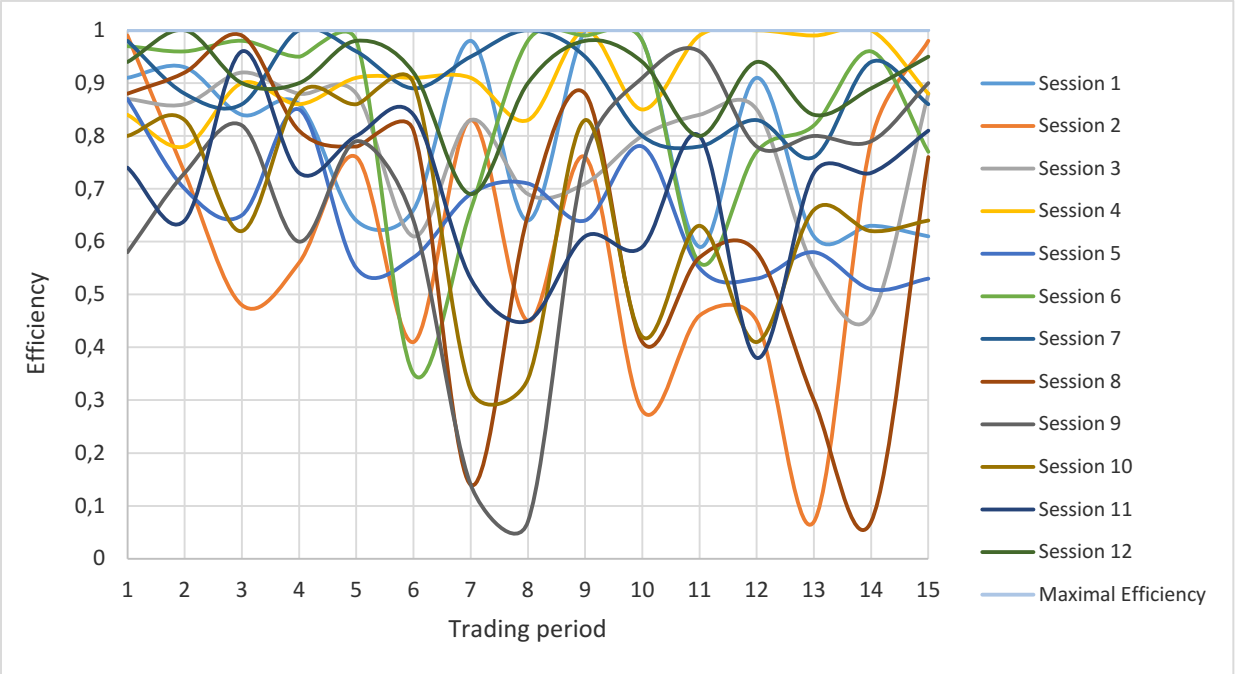


Figure 5.b
Market efficiency of the 12 sessions of the SOC market across trading periods



Mean values (standard deviations in parentheses) for quantity, total earnings of consumers and producers and efficiency (total earnings relative to maximal feasible earnings in %) for both treatments and periods 1 to 7 versus periods 9 to 15 are shown in Table 4. Efficiency is significantly higher in CAP than in SOC according to a Mann-Whitney-U-test (N=24, $p<0.001$, two-tailed). This holds for early periods (1 to 7) as well as late periods (9 to 15). Furthermore, in CAP efficiency is significantly higher in late periods than in early periods (Wilcoxon-Matched-Pairs-Signed-Ranks-test, N=12, $p=0.034$, two-tailed). So in CAP learning drives toward efficiency. In SOC, the mean efficiency level does not increase but declines over time. We can marginally reject the Null-Hypothesis ("No Learning") according to a Wilcoxon-Matched-Pairs-Signed-Ranks-test (N=12, $p=0.099$, two-tailed). We conclude:

Result 2: In CAP the traded quantity is close to the competitive equilibrium and welfare-maximizing level 20. The market realizes almost 100% efficiency and the efficiency level is increasing over time. In SOC the traded quantity is substantially below the welfare maximizing level 20. Quantity and efficiency even decrease over time. The efficiency loss of SOC compared to CAP is more than 25 percentage points for periods 9 to 15.

Table 4
Mean values for quantity, social surplus, efficiency, consumer surplus and consumer surplus share

	CAP (N = 12 sessions)		SOC (N = 12 sessions)	
	Period 1 to 7	Period 9 to 15	Period 1 to 7	Period 9 to 15
Quantity	19.90 (1.37)	20.40 (1.13)	15.38 (2.23)	13.79 (3.36)
Social Surplus	1226.10 (40.54)	1261.79 (14.91)	1008.10 (122.66)	932.26 (185.31)
Efficiency	95.79 % (3.17%)	98.58 % (1.16%)	78.76 % (9.58%)	72.83 % (14.48%)
Consumer Surplus	366.27 (203.58)	474.08 (181.33)	604.82 (88.73)	636.64 (188.83)
Consumer Surplus Share	29.62 % (15.72%)	37.60 (14.36%)	61.25 % (13.50%)	68.55 % (15.73%)

Standard deviations in parentheses.

5.4. Efficiency versus Equality

Table 4 also shows consumer surplus and consumer surplus share (consumer surplus relative to social surplus of consumers and producers in %). These two statistics are important for an assessment of distributional implications of market institutions. Namely, one issue in the debate about socialism versus capitalism is that in socialism total welfare might be smaller but the distribution of welfare is more balanced.

Hypothesis 4: The consumer surplus share is higher in SOC than in CAP!

Moreover, a social policy might strongly favour consumers such that consumers not only gain relatively but also in absolute terms. Indeed Table 4 reports that consumer surplus is absolutely and relatively higher in SOC than in CAP. These effects are significant for early as well as late periods according to Mann-Whitney-U-tests ($N=24$, $p<0.01$, two-tailed – for all four test conditions: two variables by two phases). In CAP both, consumer earnings and consumer share are significantly increasing over time (Wilcoxon, $N=12$, $p=0.019$, two-tailed – for both variables), whereas both variables do not significantly change over time in SOC – $p=0.695$ (consumer earnings) and $p=0.239$ (consumer share). The consumer surplus as measured here does not include welfare losses due to rationing. We will discuss this issue in the next subsection and summarize our findings thereafter.

5.5. Consumer Welfare Loss due to Rationing

If prices are not market clearing, specifically, if prices are too low there is excess demand which requires rationing. Rationing of consumers is a typical problem of real-existing socialist systems. It implies that some consumers are dissatisfied since they don't get to buy the good even though they are willing to pay the required price. It can be described as a welfare loss resulting from forgone trades. We refer to it as "rationing loss". The size of the consumer rationing loss can be calculated analogously to welfare gains as the difference between a consumer's valuation (the amount he/she would be willing to pay if he/she received another good) and the trade price. Individual rationing losses can be summed up for an aggregate measure. Consumer rationing losses can largely be ignored in capitalist societies. Excess demand might occur temporarily but is negligible relative to total market volume. It also plays no role in treatment CAP of the experiment where the bidding process was sufficiently long to allow the participants to realize all feasible trades. Specifically, if close to the end of the

period a consumer had been willing to buy another good at the standing ask price, he/she could have done so. Accordingly, there is no excess demand and no rationing loss in CAP.

In SOC, however, excess demand did occur in many cases causing a substantial rationing loss as shown in Table 5[14]. Excess demand occurred in 124 out of 180 SOC-markets (12 sessions times 15 periods). In periods 9 to 15 (experienced participants) average excess demand is 5.71 units causing an average rationing loss for consumers of 258.24. If this rationing loss is subtracted from consumer surplus it results in an adjusted value of 378.40 which is less than the realized consumer surplus in CAP (474.08 in periods 9 to 15, see Table 4 above). A Mann-Whitney-U-test relying on session averages reports that this difference is insignificant (N = 24, p = 0.347). Combining the findings of the last two subsections we conclude:

Result 3: If welfare losses due to rationing are ignored consumer surplus is significantly higher in SOC than in CAP. In CAP the consumer surplus share is increasing over time but stays well below the one in SOC. However, in SOC there is excess demand and a substantial consumer welfare loss due to rationing. If this is taken into account the adjusted consumer surplus is insignificantly different between treatments.

Table 5
Consumer welfare loss due to rationing

	Periods 1 to 15	Periods 1 to 7	Periods 9 to 15
Excess Demand	5.23	4.38	5.71
	(5.48)	(5.17)	(5.56)
Consumer Rationing Loss	232.73	178.93	258.24
	(328.40)	(295.52)	(334.39)
Consumer Surplus Adjusted for Rationing Loss	389.78	425.89	378.40
	(469.83)	(403.40)	(502.17)
	N = 180	N = 84	N = 84
	12 sessions by 15 periods	12 sessions by 7 periods	12 sessions by 7 periods

6. Conclusion

In our lab experiment, the socialist market institution realizes a substantial and statistically significant welfare loss compared to the capitalist market institution. The loss amounts to more than 25 percentage points whether it is measured in real terms, quantity, or in monetary

[14] See Appendix C for a more detailed table

terms, social surplus. For experienced experimental participants (periods 9 to 15) the difference in social surplus is about 330 which is about 22 times the standard deviation of social surplus in CAP. Thus, the difference is very large. It is also large relative to the usual variance observed in other experiments comparing market institutions. We conclude that the socialist market institution performs rather poorly even if democratic! In SOC trading prices show a large variance over time with no clear convergence. On the contrary in CAP trading prices converge to the competitive equilibrium price even though there are only two sellers. In SOC the pricing committee sets a price below the competitive equilibrium level. This policy is intended to favour consumers. Indeed it does serve to balance the distribution of social surplus between consumers and producers. The consumer surplus share is higher in SOC (about 69% in periods 9 to 15) than in CAP (38%). The committee's pricing policy even increases the absolute level of consumer surplus if losses due to rationing are ignored. However, excess demand and rationing losses occur regularly in SOC. If rationing losses are taken into account, the absolute levels of consumer surplus do not differ between treatments.

Overall the experiment is really bad news for supporters of socialism. Under lab conditions, which allow identical replication of market structures, the socialist institution clearly underperforms relative to the capitalist institution. The socialist institution investigated here is a rather mild form of socialism: It featured free, possibly profit-oriented producers and a democratic, politically unbiased pricing committee. In real-existing socialist systems, firms are mostly state-run, so individual incentives for producers are flawed. Furthermore, governments and administrations may be politically biased. It is to be expected that these factors reduce the economic performance of socialism even further.

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Appendix A – Instructions for the Capitalist Experiment (translated from German)

General Instructions

Welcome! This is an experiment on decision-making. You will be paid €4 for showing up. If you carefully read the instructions and follow rules you can earn additional money. The €4 and all other money earned during the experiment will be paid to you in cash immediately after the experiment. In the experiment you earn points. These points will be exchanged for Euros according to the following exchange rate: 1000 points = €3.You are not allowed to speak to other participants during the experiment. If you have a question, please ask us. We will gladly answer your questions individually. It is very important that you follow these rules.

In this experiment, we are going to simulate a market of a commodity in which some of you will be buyers and some of you will be sellers. The commodity to be traded is divided into distinct units. We will not specify a name for the commodity; we will simply refer to them as units. You will use the computer to buy or sell. The market consists of 8 participants, including you. Of the 8 participants, 6 are buyers and 2 are sellers. Whether you are a buyer or seller will be decided randomly.

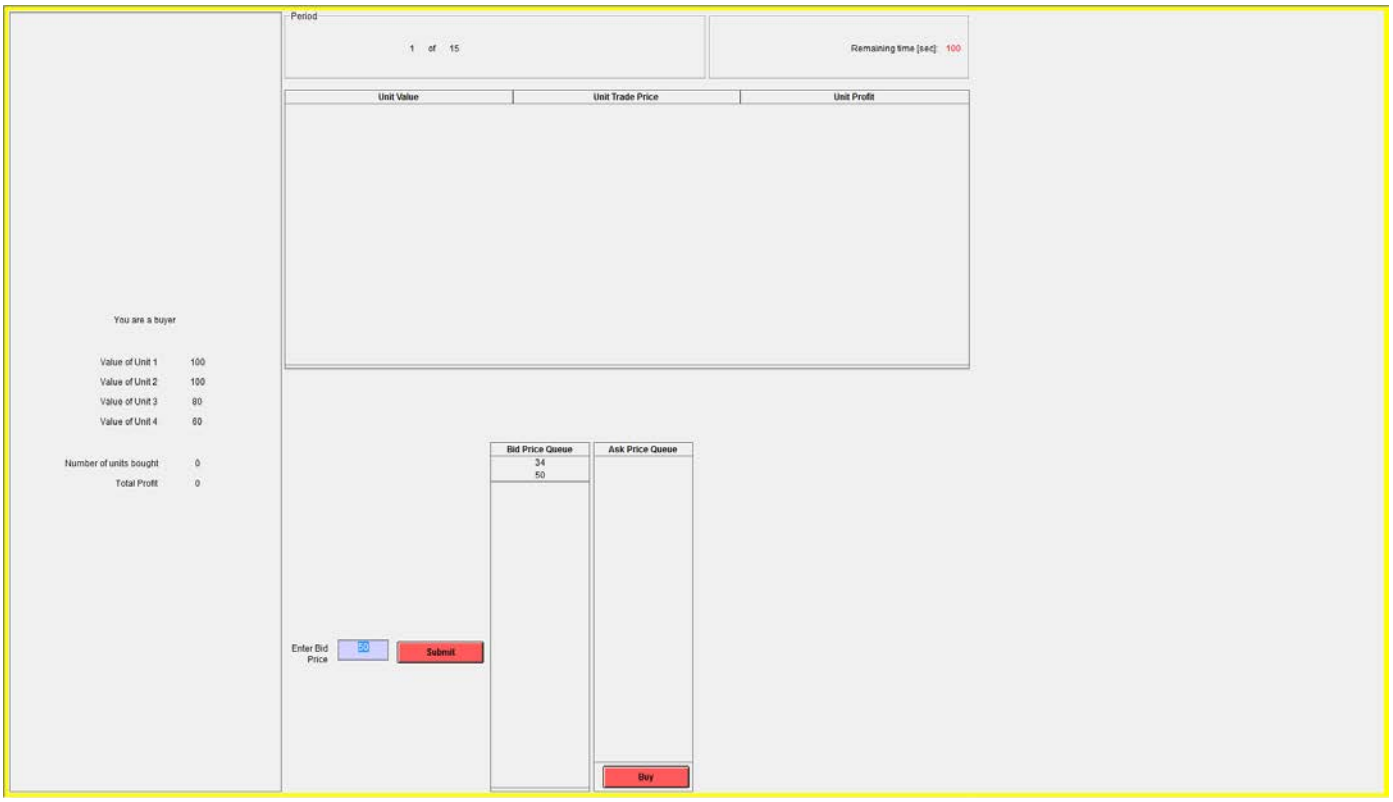
The experiment has 2 practice periods followed by 15 trading periods. In the practice periods, you do not earn money but you should take these periods seriously since you will gain valuable experience for the trading periods that are paid. Each period last 2 minutes and you may sell or buy several units in each period till the trading period closes. The length of the remaining trading time is shown in the upper right corner of the computer screen.

Buyers can submit bid prices and may accept ask prices submitted by sellers. Sellers can submit ask prices and may accept bid prices submitted by buyers. Bid prices are shown in the bid price queue and ask prices are shown in the ask price queue. Bid prices move upward since a submitted bid price must be larger than the largest price in the bid price queue. Ask prices move downward since a submitted ask price must be lower than the lowest price in the ask price queue. When a unit is sold, all previous bids and asks by this pair of traders are erased from the respective queues and trading continues. The bid and ask prices of the other traders remain in the respective queues.

Detailed Instructions for Buyers

In this experiment you are a buyer

As a buyer, you will be assigned four units of the commodity with different values. These values will be displayed on your screen as shown below



In this example that the value of the first unit is 100 points and the second unit is 100 points etc. (note that your actual values may differ from this example).

As a buyer, you can submit bid prices to buy from the sellers during a trading period. All bid prices are shown in the bid queue. If a seller accepts your bid price, this concludes a trade, which means that a unit is sold to you and you pay your bid price to the seller. Alternatively, a trade is concluded if you accept an ask price by a seller (just click on an ask price in the ask queue and then click on 'Buy'). In this case, a unit is sold to you and you pay the ask price to the seller. Whenever a trade occurs all previous bids and asks by this pair of traders are erased from the respective queues. In addition as the buyer of the unit, the value, trade price and profit for that unit will be displayed on your screen.

Your profit as a buyer is computed as follows:

Profit of Unit 1 = value of unit 1 minus the price of unit 1

Profit of Unit 1 = value of unit 1 minus the price of unit 1

Example: Suppose the value of your first unit is 100 and you bought it for 60. Your profit will be: 100 - 60 = 40. In addition, you earn profit on other units you may have bought. It is important to note that you can also make losses. If you bought a unit having value 80 at a price of 90, your profit will be: 75 - 90 = -10. So you make a loss of 10.At the end of each trading period, you will be shown a screen with the profit you made during that period.

Detailed Instructions for Sellers

<u>In this experiment you are a seller</u>

As a seller, you will be assigned 15units of the commodity with different cost. These costs will be displayed on your screen as shown below:

In the example above, the cost of your first unit is 10points and the cost of the second unit is 10 points, etc. (note that your actual costs may differ from this example).

You can submit ask prices to sell to buyers during a trading period. All ask prices are shown in the ask queue. If a buyer accepts your ask price, this concludes a trade, which means that a unit is sold by you and the buyer pays your ask price to you. Alternatively, a trade is concluded

if you accept a bid price by a buyer (just click on a bid price in the bid price queue and then click on 'Sell'). In this case a unit is sold by you and the buyer pays the bid price to you. Whenever a trade occurs all previous bids and asks by this pair of traders are erased from the respective queues. In addition as the seller of the unit, the cost, trade price and profit for that unit will be displayed on your screen.

Your profit as a producer is computed as follows:

Profit of Unit 1 = the price of unit 1 minus cost of unit 1
Profit of Unit 1 = the price of unit 2 minus cost of unit 2
Example: suppose the cost of your first unit is 10 and you sold it at 40. Your profit will be: 40 - 10 = 30. In addition you earn profit on other units you may have sold. It is important to note that you can also make losses. If you sold a unit that costs 10 for 5, your profit will be: 5 - 10 = -5. So you make a loss of 5.At the end of each trading period you will be shown a screen with the profit you made during that period.

Appendix B – Instructions for the Socialist Experiment (translated from German)

General Instructions

Welcome! This is an experiment on decision-making. You will be paid €4 for showing up. If you carefully read the instructions and follow rules you can earn additional money. The €4 and all other money earned during the experiment will be paid to you in cash immediately after the experiment. In the experiment you earn points. These points will be exchanged for Euros according to the following exchange rate: 1000 points = €3.You are not allowed to speak to other participants during the experiment. If you have a question, please ask us. We will gladly answer your questions individually. It is very important that you follow these rules.

In this experiment we are going to simulate a market of a commodity in which some of you will be buyers and some of you will be sellers. The commodity to be traded is divided into distinct units. We will not specify a name for the commodity; we will simply refer to them as units. You will use the computer to buy or sell. The market consists of 8 participants, including you. Of the 8 participants, 6 are buyers and 2 are sellers. Whether you are a buyer or seller will be decided randomly.

The experiment has 2 practice periods followed by 15 trading periods. In the practice periods you do not earn money but you should take these periods seriously since you will gain valuable

experience for the trading periods that are paid. Each period last 2 minutes and is made up of two phases, the price decision phase (up to 80 seconds) and the trading phase (up to 40 seconds).

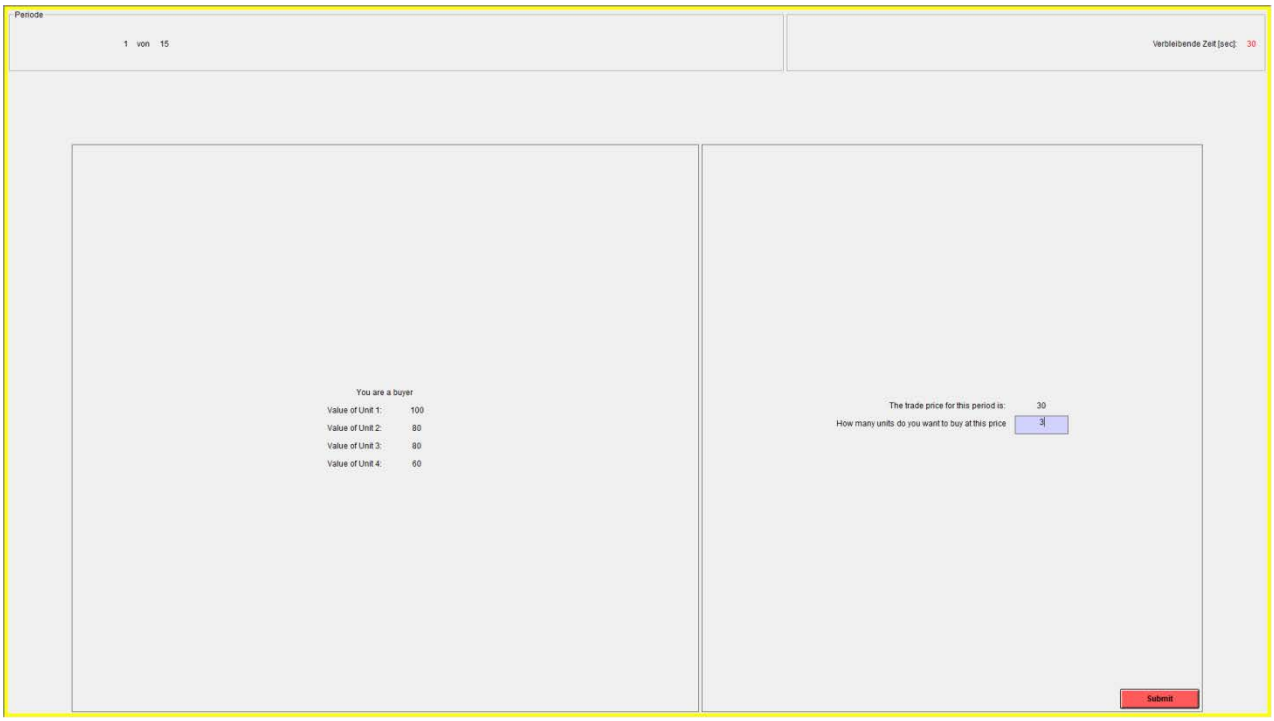
During the price decision phase, a pricing committee has to decide on the price at which a unit of a commodity should be bought and sold. The pricing committee will be made up of four participants (one seller and three buyers) randomly chosen at the beginning of the experiment. These four participants will be members of the pricing committee for all the trading periods. There will be information on your computer screen telling you if you are a member of the pricing committee or not. In the price decision phase every member of the pricing committee may propose prices. These prices will be visible to all members in the pricing committee. Each membercan change their proposal by entering a new price. The first price that is suggested by two members is the trading price for that period. If a price has not been decided by the pricing committee by the end of the price decision period a trade price will be randomly assigned.

The trading phase begins after the price decision phase. The trade price for the period is announced to all buyers and sellers. Each buyer (seller) indicates the number of units they are willing to buy (sell) at that price. If demand and supply match then sellers and buyers orders are completely fulfilled. In case of undersupply buyers are rationed (buying orders are cut at random to equate to supply) and in case of oversupply, sellers are rationed (selling orders are cut at random to equate demand). The trading phase ends after 40 seconds and sellers and buyers are informed of their purchases.

Detailed Instructions for Buyers

In this experiment you are a buyer

As a buyer, you will be assigned four units of the commodity with different values. These values will be displayed on your screen as shown below



In this example that the value of the first unit is 100 points and the second unit is 100 points etc. (note that your actual values may differ from this example).

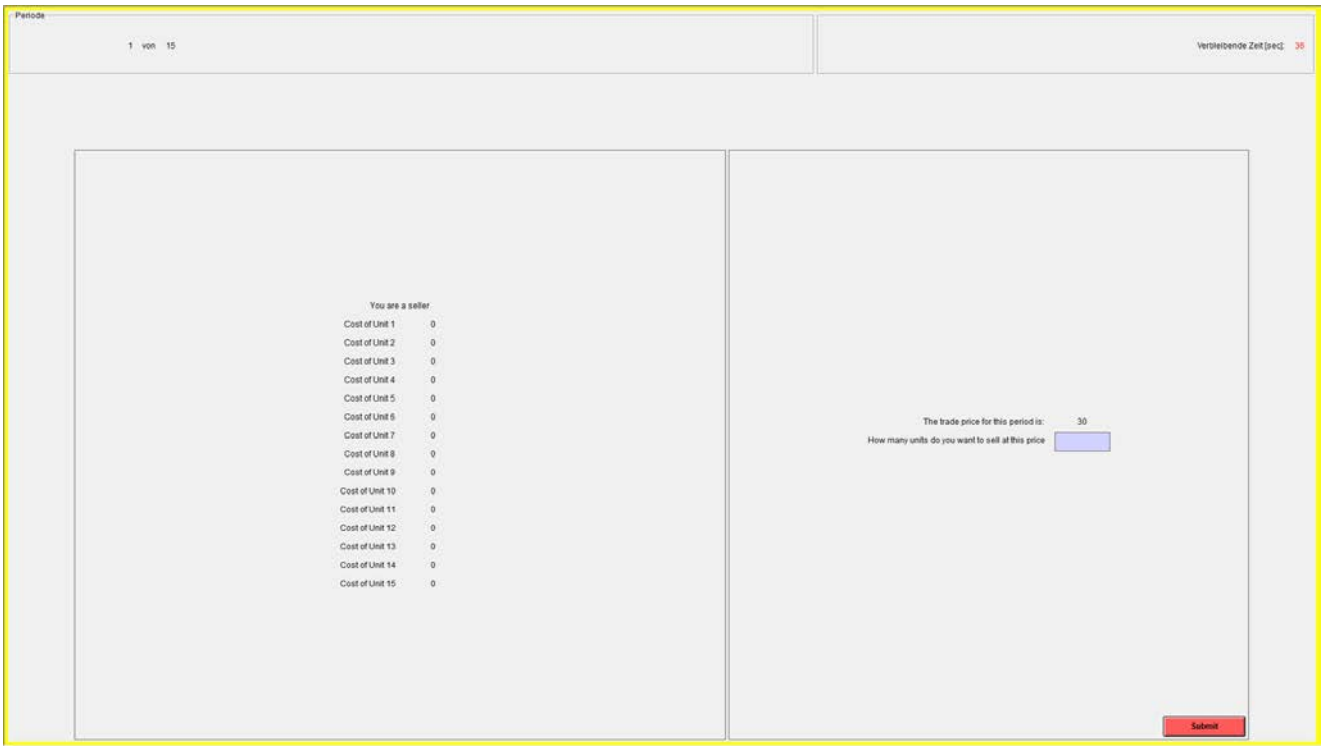
After the price decision phase is over the trade price will be displayed on your screen. You can buy up to 4 units at this price. To do so, enter the number of units you want to buy and then click “submit”. If demand and supply match then all orders are completely fulfilled and you will receive all the units you requested. In case of undersupply buyers are rationed (buying orders are cut at random to equate to supply). In this case you might not buy all the units you wanted to buy.

Your profit as a buyer is computed as follows:
Profit of Unit 1 = value of unit 1 minus the trade price
Profit of Unit 1 = value of unit 1 minus the trade price
Example: Suppose the value of your first unit is 100 and you bought it for 60. Your profit will be: 100 - 60 = 40. In addition you earn profit on other units you may have bought. It is important to note that you can also make losses. If you bought a unit having value 80 at a price of 90, your profit will be: 75 - 90 = -10. So you make a loss of 10. At the end of each trading period you will be shown a screen with the profit you made during that period.

Detailed Instructions for Sellers

In this experiment you are a seller

As a seller, you will be assigned 15units of the commodity with different cost. These costs will be displayed on your screen as shown below:



In the example above, the cost of your first unit is 10points and the cost of the second unit is 10 points, etc. (note that your actual costs may differ from this example).

After the price decision phase is over the trade price will be displayed on your screen. You can sell up to 15 units at this price. To do so, enter the number of units you want to sell and then click “submit”. If demand and supply match then all orders are completely fulfilled and you will sell all the units you requested to be sold. In case of oversupply sellers are rationed (selling orders are cut at random to equate to demand). In this case you might not sell all the units you wanted to sell.

Your profit as a producer is computed as follows:

Profit of Unit 1 = the trade price minus cost of unit 1

Profit of Unit 1 = the trade price minus cost of unit 2

Example: suppose the cost of your first unit is 10 and you sold it at 40. Your profit will be: 40 - 10 = 30. In addition you earn profit on other units you may have sold. It is important to note

that you can also make losses. If you sold a unit that costs 10 for 5, your profit will be: 5 - 10 = -5. So you make a loss of 5.At the end of each trading period you will be shown a screen with the profit you made during that period.

Appendix C – Consumer Welfare Loss due to Rationing

	Periods 1 to 15	Periods 1 to 7	Periods 9 to 15
Excess Demand	5.23 (5.48)	4.38 (5.17)	5.71 (5.56)
Excess Supply	1.44 (3.46)	1.46 (3.12)	1.60 (3.97)
Consumer Rationing Loss	232.73 (328.40)	178.93 (295.52)	258.24 (334.39)
Producer Rationing Loss	13.40 (114.91)	7.98 (93.06)	21.69 (139.96)
Consumer Earnings	622.52 (262.48)	604.82 (238.26)	636.64 (282.97)
Producer Earnings	337.71 (274.35)	403.27 (284.07)	295.62 (258.41)
Total Earnings	960.23	1008.09	932.26
Consumer Surplus Adjusted for Rationing Loss	389.78 (469.83)	425.89 (403.40)	378.40 (502.17)
Producer Surplus 2	324.31 (254.44)	395.30 (273.44)	273.93 (222.29)
	N = 180 12 sessions by 15 periods	N = 84 12 sessions by 7 periods	N = 84 12 sessions by 7 periods

PAPER 2:

Improving Efficiency in Socialism - A Laboratory Experiment

Abstract

The weakness of socialism can be mostly attributed to the fact that prices are not determined by market forces, but by a central authority. Can the kind of members that constitute this central authority (which I refer to here as a price-setting committee) affect efficiency in a socialist market? In other words, does efficiency improve or decrease if the price-setting committee is representative of the society? In this experiment I investigate the effect of political bias in the price-setting committee on the efficiency of a socialist market. In the socialist market a price-setting committee decides on the price at which a good should be traded. Once the price has been decided on, the other market participants are informed of the price and they can submit how many units of the good they are willing to sell/buy at this price. If total demand and supply do not match, the longer market side is randomly rationed. In the first treatment the price-setting committee is a representation of the entire population (sellers and three types of buyers). In the second treatment the price-setting committee consist of sellers and one type of buyer. In the third treatment the price-setting committee only consist of buyers. The findings indicate that bias in the constitution of the price-setting committee of a socialist market affects trade price and profit distribution, but has no effect on efficiency and trade quantity.[15]

[15] The design used in this paper was Prof. Dr. Manfred Königstein´s idea.

1. Introduction

In a socialist market, firms are owned and controlled by the state. Those in support of market socialism most often assume that the state will always look for an efficient means of allocating resources. Lange (1936) states that a socialist market is superior to a market economy for a number of reasons. Firstly, in a socialist market since the state sets prices, and determines entry, it can avoid monopolies. Secondly, since the state controls all firms, it can solve the problem of externalities. Thirdly, the state can distribute income more fairly. However, the main problem with a socialist market is that it does not have sufficient information to determine equilibrium prices (Mises, 1920). Lange (1936) proposed that government officials in a socialist market can follow the same procedure of price adjustment as in a market economy. According to Hayek and Robbins, the problem with this is that in the real world consumers wants and available resources are continually changing. Therefore, by the time those who set prices in a socialist market have obtained all the information needed to determine the price change the resulting prices would be inapplicable to the existing economy (Mises, 1920 p. 61). Hence one of the main weakness of socialist society is the fact that prices are not determined by market forces. In a capitalist market, prices are controlled by market forces. These prices communicate information about scarcity and abundance. For example in a market economy, consumers know that when the price of a good is high, that signals scarcity, and when the market price is low, it signals abundance. With these information consumers can act accordingly. On the other hand, in a socialist economy where prices are set by a central authority, the information transmitted by the prices are false.

It has been proposed that the failure of socialist states is due in part to the government officials´ abuse of their position by making decisions that advances their political agenda instead for the interest of the people. Can the makeup of the price-setting committee influence efficiency? Is a price-setting committee that is representative of the population more efficient than a bias one? These are the questions I seek to answer.

In this study, the market efficiency of a socialist market is investigated under three treatments. There are different views on how a socialist market should be modelled, ranging from liberal forms that consist of a free market economy with a social transfer system to extreme forms where the state allocates everything. The socialist market in this study is in between. While prices being set by central authorities is common in real-existing socialist societies, producers

and consumers deciding freely about supply and demand is less common. It is important to state that this laboratory socialist market is just a simple and special cases of real-existing socialist economy systems.

The objective of this study is to determine the effect of political bias in the price-setting committee of a socialist market on market efficiency. In the experimental market, there are four types of participants, namely, high-value buyers, intermediate-value buyers, low-value buyers and sellers. In the first treatment, the price-setting committee is made up of high-value buyers, intermediate-value buyers, low-value buyers, and sellers (it represents every participant type). Bias in the second treatment is implemented by a price-setting committee that is made up of only sellers and high-value buyers. In treatment three the price-setting committee is made up of intermediate-value and low-value buyers. Market supply and demand is identical in all three treatments.

The rest of the paper is organized in the following manner. The experimental design and procedure are summarized in the next section, Section 3 reports the experimental results, and Section 4 concludes.

2. Methods

2.1. Experimental Design

The markets are conducted as a socialist market, whereby a price-setting committee decides on a trading price. This price is then announced to all buyers and sellers. Each buyer (seller) submits how many units they are willing to buy (sell) at the given price. The longer market side is randomly rationed, in case quantity demanded does not equal quantity supplied. There are six buyers, two for each of three buyer types (low, intermediate and high valuation)[16] and two symmetric sellers. Each buyer may buy up to four units of the good. Buyers´ valuations for each unit bought are shown in Table 1. Each seller may sell up to 15 units. Sellers´ cost schedules are shown in Table 2.

[16]Buyers 1 and 2 are high-value buyers, buyers 3 and 4 are intermediate-value buyers and buyers 5 and 6 are low-value buyers (see Table 1).

Table 1
Buyers´ valuations

Units	1	2	3	4
Buyer 1	100	100	80	60
Buyer 2	100	100	80	60
Buyer 3	100	80	80	60
Buyer 4	100	80	80	60
Buyer 5	100	80	60	60
Buyer 6	100	80	60	60

Values are in experimental currencies.

Table 2
Sellers´ costs

Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Seller 1	10	10	10	10	10	30	30	30	30	30	70	70	70	70	70
Seller 2	10	10	10	10	10	30	30	30	30	30	70	70	70	70	70

Costs are in experimental currencies.

2.2. Treatments

The experiment consists of three treatments. In the first treatment, the price-setting committee is representative of the entire market population. That is, it is made up of one member from each of the buyer types (low, intermediate and high) and sellers. This treatment will be referred to as SHILB henceforth. In treatment two, SHB thereafter, the price-setting committee is made up of two sellers and two high-value buyers. In treatment three, ILB thereafter, the price-setting committee is made up of two intermediate and two low-value buyers. Table 3 gives a summary of the experimental sessions implemented.

Table 3
Summary of experimental sessions

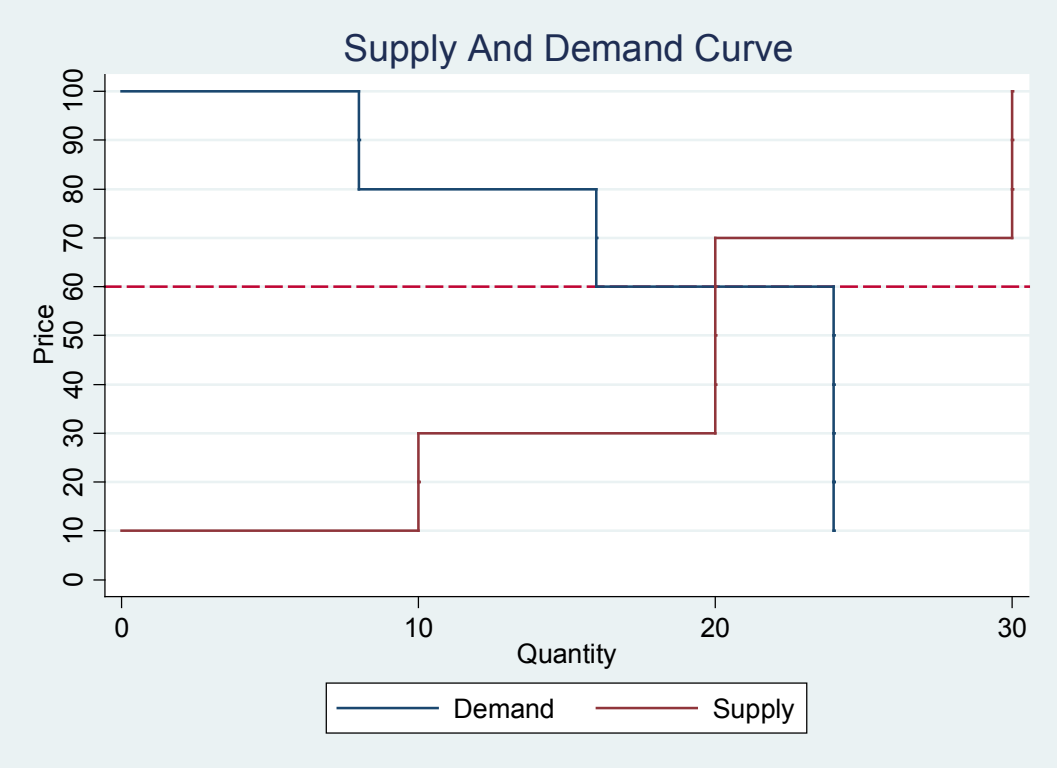
Treatment	Name	Number of sessions	Pricing Committee
1	SHILB	12	1 low-value buyer 1 intermediate-value buyer 1 high-value buyer 1 seller
2	SHB	12	2 sellers 2 high-value buyer
3	ILB	12	2 intermediate-value buyers 2 low-value buyers

2.3. Theoretical Predictions

Figure 1 shows the market demand and supply function. The value and cost structure for all subjects determines the aggregate supply and demand functions and thus the equilibrium price and quantity (see Davis & Holt, 1993). The price and quantity at which the demand and supply curve intersect is the equilibrium price and quantity, respectively. Looking at the curve one can clearly see that the resulting competitive equilibrium in this market is a price of 60, a quantity of 20, and a total trading surplus of 1280. The trading surplus is the area between the induced supply and demand curves. It is the maximum sum of all buyers´ and sellers´ earnings that could be made in a period. A market that is 100% efficient extracts all the possible surplus that could be made by the traders. At the equilibrium price of 60, sellers can earn up to 62.5% of the maximum possible gains from trading, whereas buyers can earn 37.5%.

In this experimental market, the price-setting committee decides on prices collectively by majority vote. If the price-setting committee seeks to maximize efficiency, it may lead to the same result as the competitive equilibrium. The equilibrium quantity could also be traded at a price of 30 (see Figure 1) inducing a consumer surplus of 1080 (84.4% of total surplus) and a producer surplus of 200(15.6% of total surplus). If the members of the price-setting committee´s interest is their own benefit, committee members could form a coalition to maximize their own payoff. A buyer coalition is possible in treatment 1 and 3.

Figure 1
Induced aggregate market supply and demand curve



2.4. Experimental Procedure

The experiments were carried out in the ERFURTER LABORATORIUM FÜR EXPERIMENTELLE WIRTSCHAFTSFORSCHUNG (eLab), Germany (in German) and participants were recruited using the software package ORSEE (Greiner, 2004). The experiment was programmed using the software program z-tree (Fischbacher, 2007)[17]. To make sure the rules of the experiment were understood, subjects received written instructions before the experiment began. They were also given some time to ask clarifying questions concerning the experiment privately. Written instructions pertaining to the experiment are attached to Appendix A. The instructions in the appendix have been translated from German into English. In the laboratory, participants sat in separate cabins and they were identified only by a number. Privacy and anonymity were implemented to minimized subject bias in the experimental market. A total of twelve experimental sessions were conducted for each of the three treatments. Each subject participated in only one session and acted as either a buyer or a seller. In each session, there were six buyers and two sellers. Subjects were randomly assigned the role of a buyer or a seller.

[17] Codes can be provided upon request.

Each experimental session consisted of two trial (non-paid) periods and fifteen trading periods each lasting 2 minutes. Results of the two trial periods were excluded from analysis. Each trading period represents a market day. Buyers/sellers were given a list of units and their corresponding unit values/costs. A unit value is the maximum price a buyer is willing to pay for that unit of the commodity whereas a unit cost is the minimum price a seller is willing to sell that unit of the commodity. These values and costs were the same in all the trading periods. Traders had no information about the unit values and costs of other traders. Profit was only made if a unit was sold, in which case the buyer earned the difference between the unit valuation of the traded commodity and the price at which it was traded. Sellers' profits were the difference between the price and the unit cost of the traded commodity. Individual profits were calculated and displayed on the individual´s computer screen after each trading period. Profit was displayed in terms of experimental currency, which was converted into euros at the rate of 1000experimental currency = €3. Accumulated profits were paid in cash at the end of each experimental session. Participants also received a show-up fee of €4 in addition to their earnings.[18]

3. Experimental Results

3.1. Bias Effect on Price

Figure 2, 3 and 4 show the observed price and quantity of a single SHILB, SHB and ILB session, respectively. Each dot represents a trade price and the number next to the dot are the units that were traded at that price. The price range that is consistent with efficiency is represented by the dashed horizontal lines. In the SHILB session, most of the prices are below the efficient price range, whereas in the SHB session, all prices are above or at the competitive price, 60. In the ILB session, prices seem to be somewhat evenly distributed between and below the efficient range.

[18] Davis and Holt (1993, p. 24-26) discuss the importance of reward in an experimental settings.

Figure 2
Observed trade prices and corresponding quantities of one SHILB session

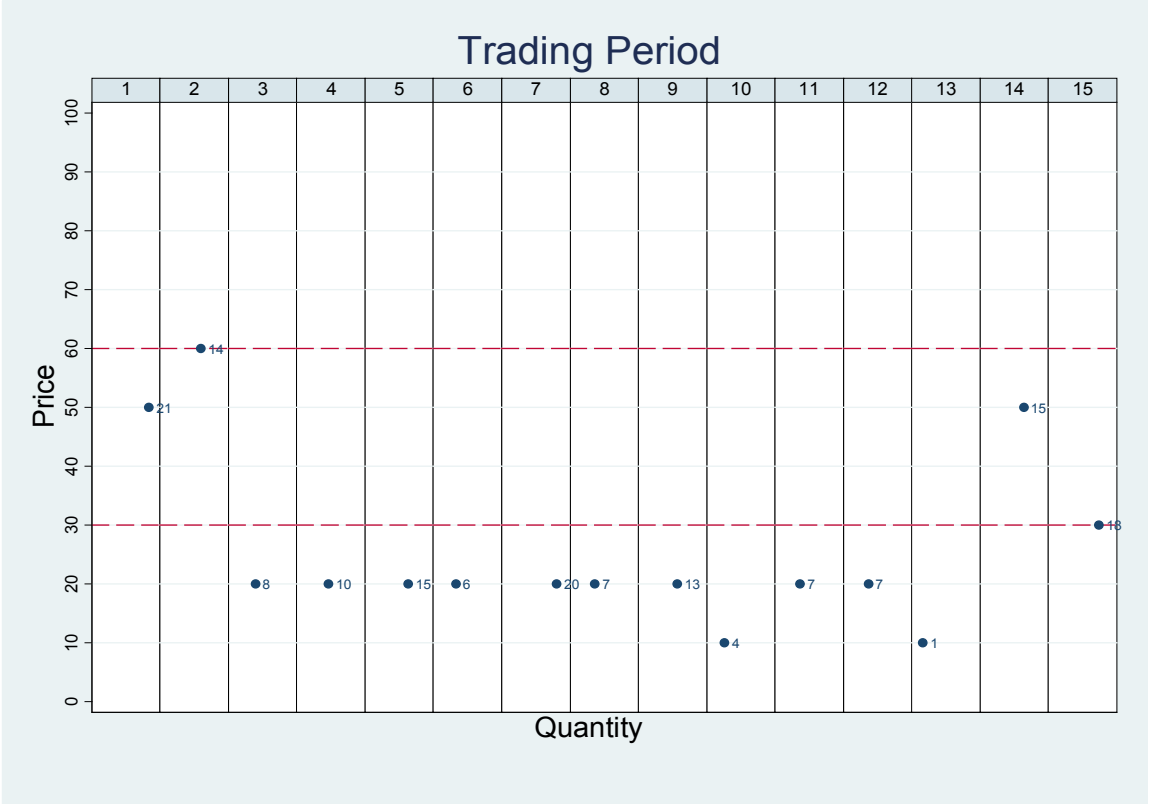


Figure 3
Observed trade prices and corresponding quantities of one SHB session

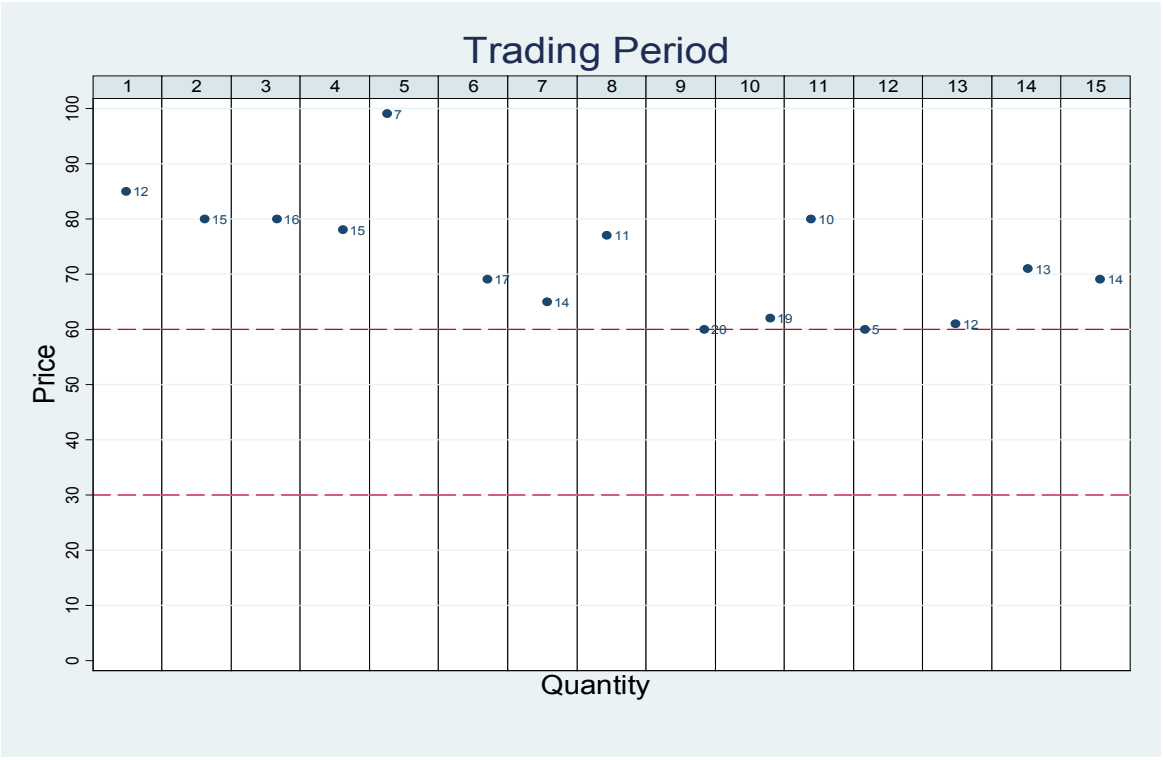
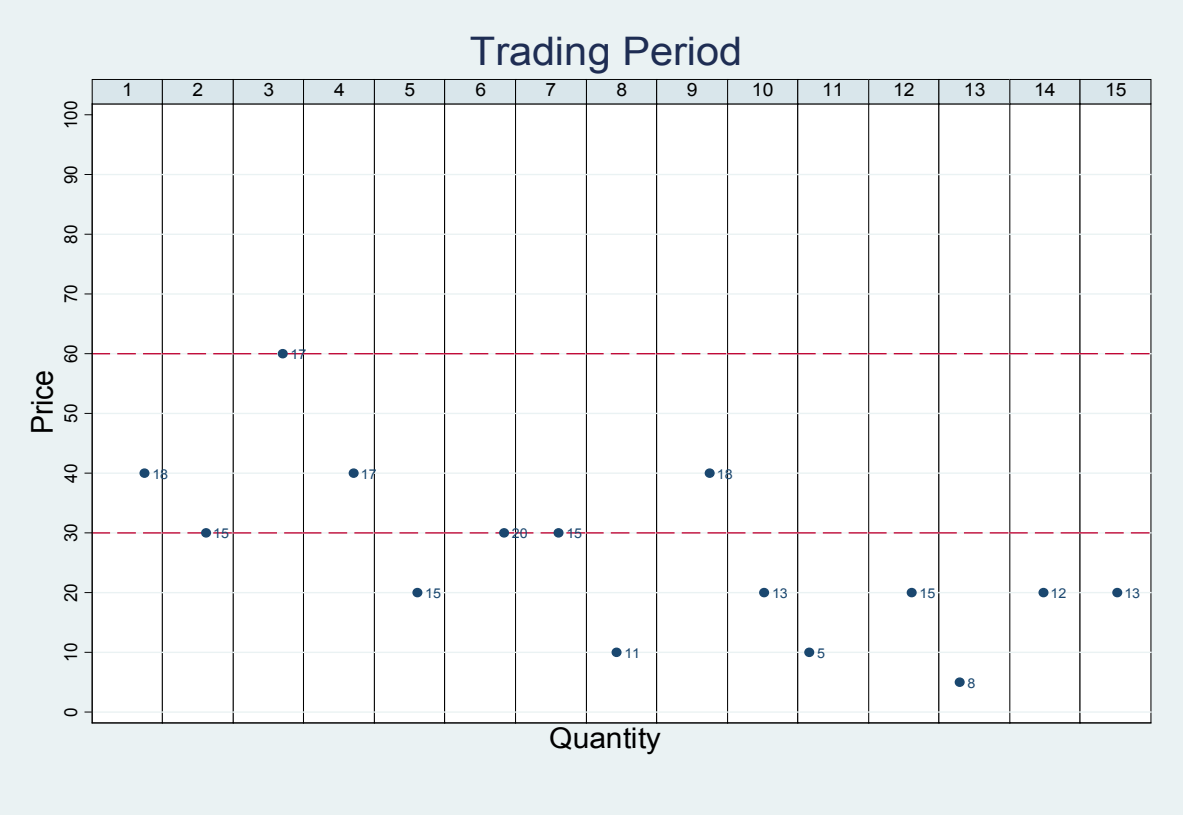


Figure 4
Observed trade prices and corresponding quantities of one ILB Session



Hypothesis 1: Political bias in the price-setting committee has an effect on trade price.

To determine if price variation reduces with periods, I compute the coefficient of variation[19] of trade prices over periods 1 to 7 as well as periods 9 to 15 for each of the 12 sessions of the three treatments.[20] If the coefficient of variation is smaller in the late periods than the early periods, this is an indication of convergence. Table 4 shows the percentage change in variation between the early and the late periods for each of the 12 sessions of each treatment. In the SHILB sessions, the coefficient of variation increases in 6 out of 12 sessions. However the null hypothesis cannot be rejected (Wilcoxon signed-rank test, N=12, p = 0.3882, two-tailed). In the SHB sessions, the coefficient of variation decreases in 8 out of 12 session and the null hypothesis cannot be rejected in this treatment too(Wilcoxon signed-rank test N=12, p = 0.4800, two-tailed). In the ILB sessions, the coefficient of variation increases in 8 out of 12 sessions. The null hypothesis cannot be rejected. (Wilcoxon signed-rank test, N=12, p = 0.2393, two-tailed). On this basis, I draw my first conclusion.

[19] The coefficient of variation is the ratio of the standard deviation to the mean (standard deviation /mean).
[20]Periods 1 to 7 and periods 9 to 15 are known as early and late periods, respectively.

Result 1a: Variation in price dispersion does not change over periods in all three treatments.

Table 4
Percentage change in variation between early and late periods

	Treatment		
Session	SHILB (%)	SHB(%)	ILB(%)
1	9	-18	59
2	8	-1.8	-73
3	3	115	79
4	-23	-25	128
5	-39	-25	-62
6	6	42	24
7	-39	-47	24
8	308	51	-33
9	-55	-7	271
10	-45	-16	-78
11	16	-66	438
12	-52	-9	69

To test for convergence to the equilibrium price, I use the Ashenfelter-El-Gamal regression model (Noussair et al; 1995, 1997). The model is specified as follows

$$y = \alpha_1 \cdot T1_{SHILB} + \alpha_2 \cdot T2_{SHILB} + \beta_1 \cdot T1_{SHB} + \beta_2 \cdot T2_{SHB} + \lambda_1 \cdot T1_{ILB} + \lambda_2 \cdot T2_{ILB} \quad (3.1)$$

With y representing the outcome variable (e.g. trade price, number of trades, efficiency etc.), and α_1, α_2, β_1,β_2,λ_1 and λ_2 being the estimated coefficients. The independent variables are defined as follows:

$$T1_{SHILB} = \begin{cases} \frac{1}{t} & \text{if treatment 1} \\ 0 & \text{if treatment 2 or 3} \end{cases} \quad T2_{SHILB} = \begin{cases} \frac{t-1}{t} & \text{if treatment 1} \\ 0 & \text{if treatment 2 or 3} \end{cases}$$

$$T1_{SHB} = \begin{cases} \frac{1}{t} & \text{if treatment 2} \\ 0 & \text{if treatment 1 or 3} \end{cases} \quad T2_{SHB} = \begin{cases} \frac{t-1}{t} & \text{if treatment 2} \\ 0 & \text{if treatment 1 or 3} \end{cases}$$

$$T1_{ILB} = \begin{cases} \frac{1}{t} & \text{if treatment 3} \\ 0 & \text{if treatment 1 or 2} \end{cases} \quad T2_{ILB} = \begin{cases} \frac{t-1}{t} & \text{if treatment 3} \\ 0 & \text{if treatment 1 or 2} \end{cases}$$

t = 1, 2, …, 15 indexes the period. As t gets bigger, $\frac{1}{t}$approaches zero, and $\frac{t-1}{t}$ approaches 1, hence α_1 is an estimate of the initial price and α_2 is the asymptotic price for treatment 1. Likewise, β_1 and β_2 are the initial and asymptotic price for treatment 2, and λ_1 and λ_2 are the initial and asymptotic price for treatment 3. This model can be used to test the hypothesis that price is converging to the competitive equilibrium by testing whether the asymptotic

price is significantly different from the theoretical predictions. The variable is said to strongly converge to the competitive equilibrium if the asymptotic is not statistically different from the theoretical predictions (Noussair et al; 1997). Noussair et al (1995) pointed out that we can also observe weak convergence. Weak convergence is the case in which the asymptote is closer to the competitive equilibrium than to the corresponding estimated starting value, that is, for treatment 1

$|\alpha_2$-Competitive equilibrium$| < |\ \alpha_2 - \alpha_1|$

In addition, comparing estimated initial price and the asymptotic price reveals the direction of convergence. If the fitted regression line shows that initial price > asymptotic price, then the regression line is positively sloped, indicating converges to asymptote from above. On the other hand, if initial price < asymptotic, this indicates converges from below. The results of Ashenfelter-El-Gamal regression are presented in Table 5 below.

Table 5

Price estimates of the Ashenfelter-El-Gamal regression model

Coefficient	**SHILB**	**SHB**	**ILB**
α_1	55.95***		
α_2	36***		
$\|\alpha_2$-60$\|$	4.05		
$\|\alpha_2 - \alpha_1\|$	19.95		
$\|\alpha_2$-60$\|$-$\|\alpha_2 - \alpha_1\|$	F=0.59		
$ß_1$		70.65***	
$ß_2$		51.21***	
$\|ß_2$-60$\|$		8.79	
$\|ß_2 - ß_1\|$		19.44	
$\|ß_2$-60$\| = \|ß_2 - ß_1\|$		F = 4.11*	
λ_1			61.50***
λ_2			35.36**
$\|\lambda_2$-60$\|$			24.64
$\|\lambda_2 - \lambda_1\|$			26.14
$\|\lambda_2$-60$\|$-$\|\lambda_2 - \lambda_1\|$			F = 0.08

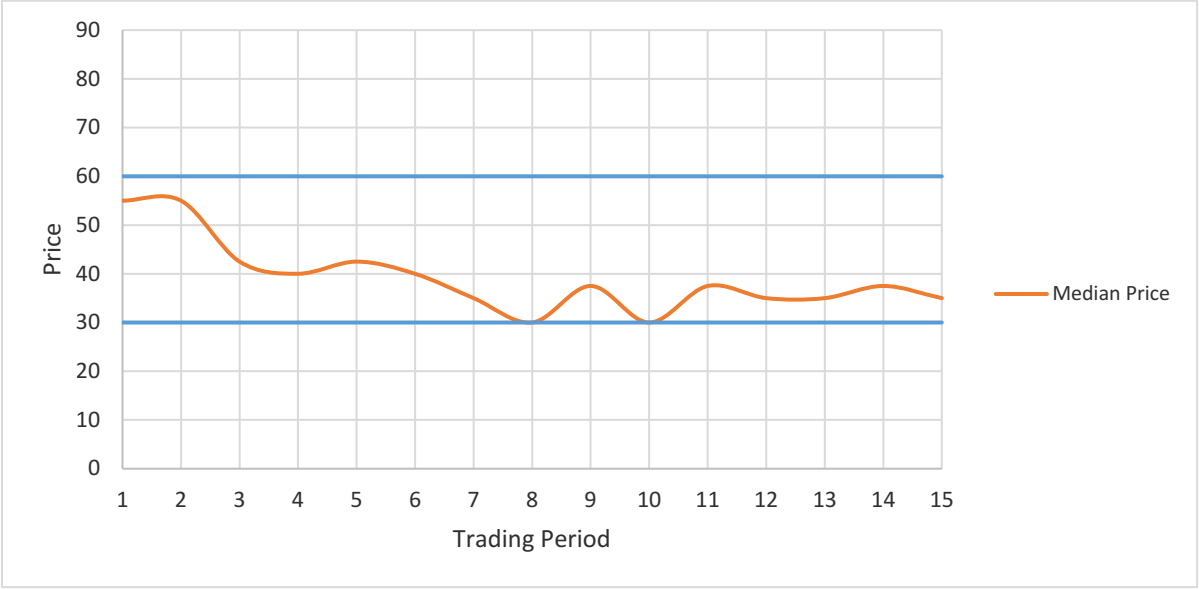
***** p<0.01, ** p<0.05, * p<0.1**

In the early periods of treatment 1, trade prices are lower (55.95) than the equilibrium price and the null hypothesis of these prices being equal to the equilibrium price cannot be rejected (p-value = 0.4418)[21]. Over periods the prices decrease to the estimated asymptotic price, 36,

[21] All reported p-values refer to two-tailed test.

which is significantly different from the equilibrium price of 60 (p-value = 0.000). In the early period of treatment 2, trade prices are higher (70.65) than the equilibrium price and the null hypothesis of early periods prices being equal to the equilibrium prices can be rejected (p-value = 0.0432). The asymptotic price (51.21) is significantly different from the competitive price (p-value = 0.000). However, $|ß_2\text{-}60|$ is significantly less than $|ß_2\text{-}ß_1|$, thereby suggesting weak convergence to the equilibrium price. In the early periods of treatment 3, trade prices are slightly above (61.50) the equilibrium price and the null hypothesis of these prices being equal to the equilibrium price cannot be rejected (p-value = 0.7751). The asymptotic price (35.36) is significantly different from the equilibrium price of 60 (p-value = 0.000). Figure 5, 6 and 7 show the median [22] prices (per session) over periods for treatment 1, 2 and 3, respectively.[23] The solid horizontal lines represent the competitive price of 60 and the lowest price (30) at which efficiency can be achieved. Any price within this range is consistent with efficient allocation. While the median trade prices for all three treatment remain within the efficient price range, only treatment 2 shows some converge towards the equilibrium price.

Figure 5
Time path of median price for all 12 sessions of the SHILB treatment across periods



[22] Most averages in this study are reported in terms of median because of the presences of a few extreme values.
[23] See Appendix B for graphs showing the observed trade prices by period of each of the twelve sessions of each treatment.

Figure 6
Time path of median price for all 12 sessions of the SHB treatment across periods

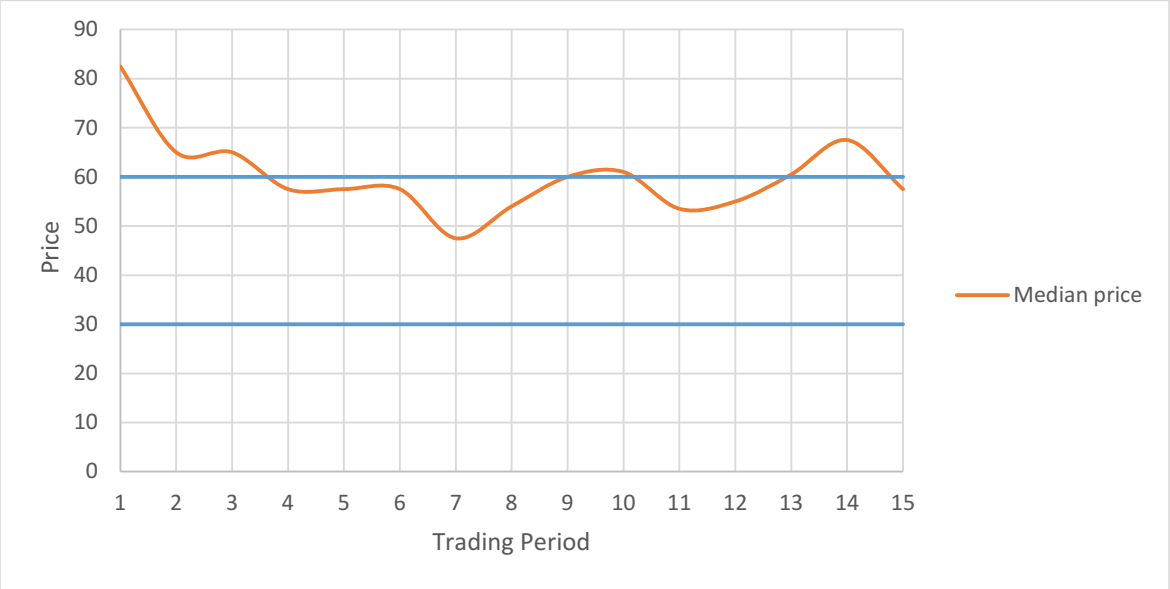
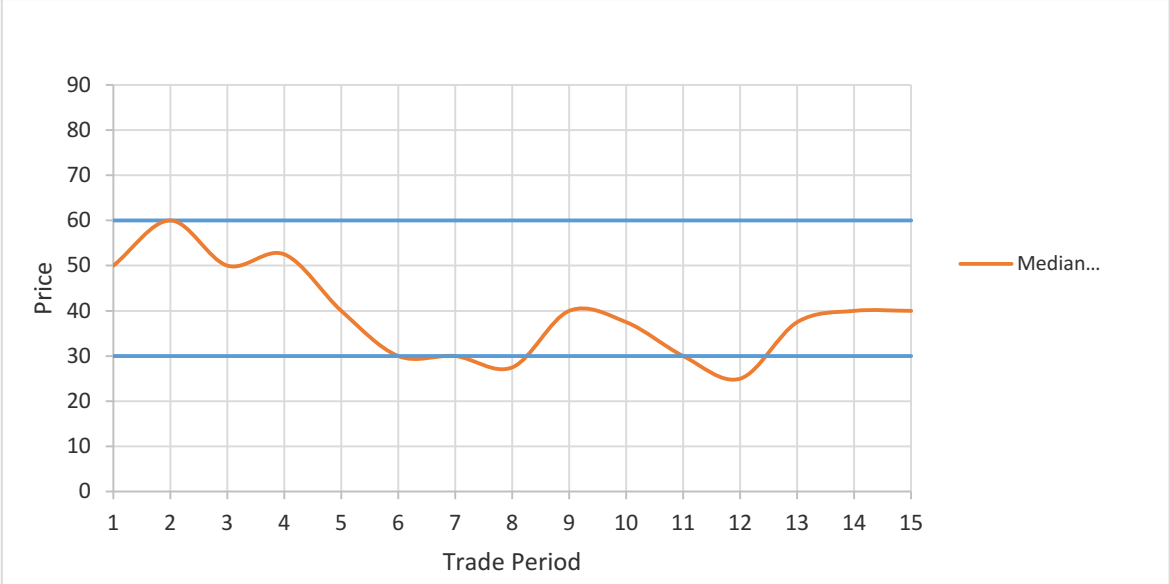


Figure 7
Time path of median price for all 12 sessions of the ILB treatment across periods



Result 1b: The trade prices do not converge to the equilibrium price in treatments 1 and 3(SHILB and ILB).

Result 1c: The trade prices weakly converges to the equilibrium price in treatment 2 (SHB).

Result 1d: In all three treatments, the estimated asymptotic price is in the range [30, 60] which allows for efficiency.

Result 1e: The mean trade price of the SHB treatment is statistically greater than the SHILB and the ILB treatment (Wilcoxon signed-rank test, N=12, p = 0.0000, two-tailed).

3.2. Bias Effect on Quantity Traded

Table 6 reports trade quantity estimates using the Ashenfelter-El-Gamal regression (Equation 3.1).

Table 6
Quantity estimates of the Ashenfelter-El-Gamal regression model

Coefficient	**SHILB**	**SHB**	**ILB**
α_1	18.05***		
α_2	13.36***		
$\lvert\alpha_2\text{-}20\rvert$	6.64		
$\lvert\alpha_2\text{-}\alpha_1\rvert$	4.69		
$\lvert\alpha_2\text{-}20\rvert\text{-}\lvert\alpha_2\text{-}\alpha_1\rvert$	F=2.28		
$ß_1$		11.50***	
$ß_2$		14.49***	
$\lvert ß_2\text{-}20\rvert$		5.51	
$\lvert ß_2\text{-}ß_1\rvert$		2.99	
$\lvert ß_2\text{-}20\rvert=\lvert ß_2\text{-}ß_1\rvert$		F = 43.38***	
λ_1			14.68***
λ_2			13.33**
$\lvert\lambda_2\text{-}20\rvert$			6.67
$\lvert\lambda_2\text{-}\lambda_1\rvert$			1.35
$\lvert\lambda_2\text{-}20\rvert\text{-}\lvert\lambda_2\text{-}\lambda_1\rvert$			F = 16.94***

***** p<0.01, ** p<0.05, * p<0.1**

In all three treatments, the estimated asymptotic quantities (Table 6) is significantly different from the equilibrium quantity of 20 (p-value = 0.000). As can be seen in figure 8, 9 and 10, the median number of trades across periods in all three treatments are similar.[24]

Hypothesis 2: Political bias in the price-setting committee has an effect on the number of trades.

[24]See Appendix C for graphs showing the observed number of trades by period of each of the twelve sessions of each treatment.

Figure 8
Time path of median quantity for all 12 sessions of the SHILB treatment across periods

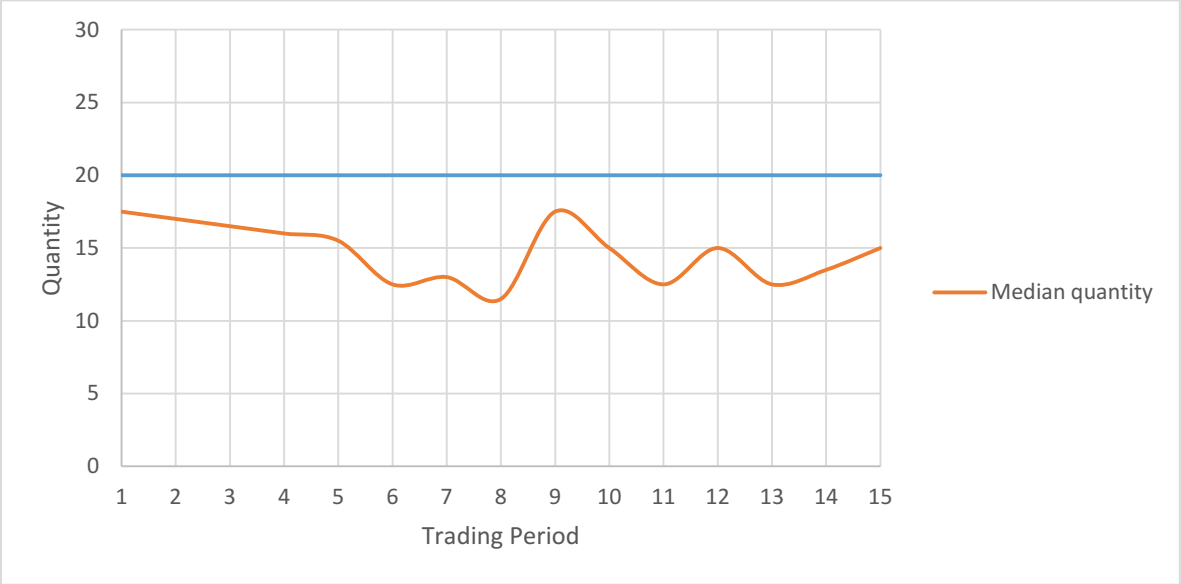


Figure 9
Time path of median quantity for all 12 session of the SHB treatment across periods

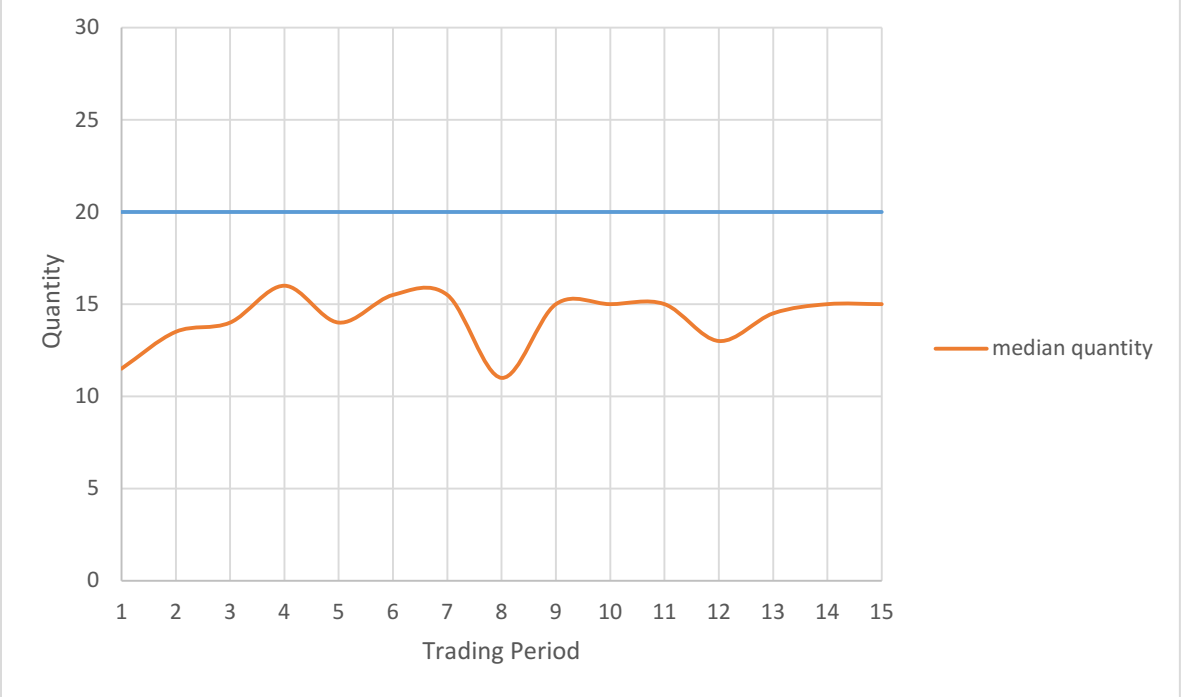
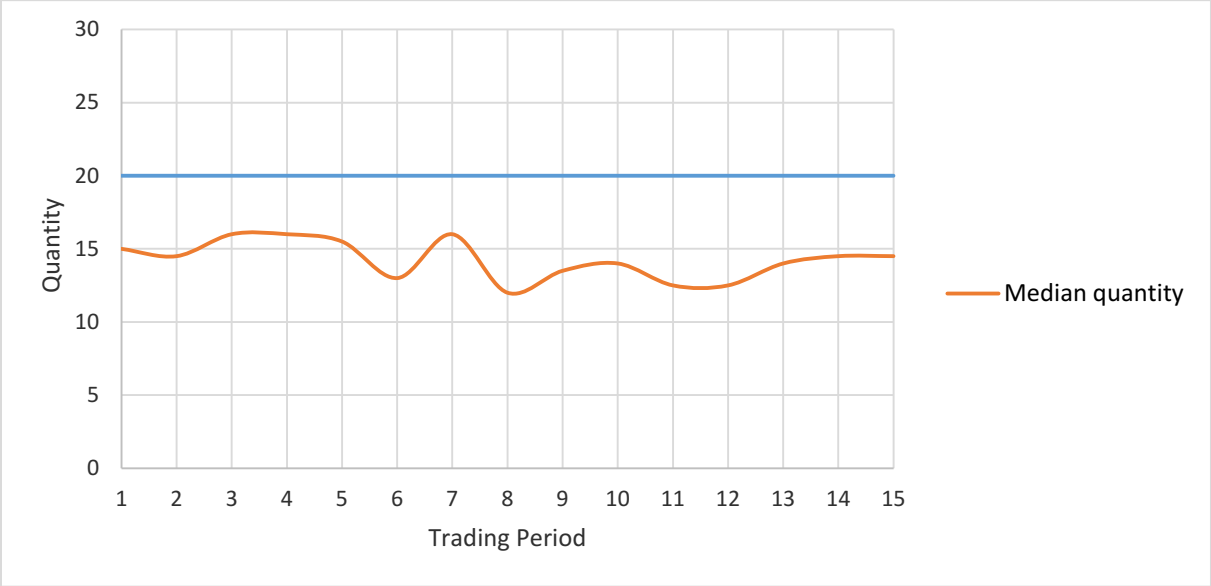


Figure 10
Time path of median quantity for all 12 sessions of the ILB treatment across periods



Result 2a: The number of trades does not converge to the equilibrium quantity in all three treatments.

Result 2b: The average number of trades are similar for all three treatments.

3.3. Bias Effect on Market Efficiency

Table 7 report efficiency estimates using the Ashenfelter-El-Gamal regression (Equation 3.1)

Table 7
Efficency estimates of the Ashenfelter-El-Gamal regression model

Coefficient	SHILB	SHB	ILB
α_1	0.90***		
α_2	0.71***		
$\lvert\alpha_2-1\rvert$	0.29		
$\lvert\alpha_2-\alpha_1\rvert$	0.19		
$\lvert\alpha_2-1\rvert-\lvert\alpha_2-\alpha_1\rvert$	F=3.35*		
$ß_1$		0.67***	
$ß_2$		0.75***	
$\lvert ß_2-1\rvert$		0.25	
$\lvert ß_2-ß_1\rvert$		0.08	
$\lvert ß_2-1\rvert=\lvert ß_2-ß_1\rvert$		F = 37.03***	
λ_1			0.79***
λ_2			0.71**
$\lvert\lambda_2-1\rvert$			0.29
$\lvert\lambda_2-\lambda_1\rvert$			0.08
$\lvert\lambda_2-1\rvert-\lvert\lambda_2-\lambda_1\rvert$			F = 14.99***

***** p<0.01, ** p<0.05, * p<0.1**

In all three treatments, the estimated asymptotic efficiency (Table 7) is significantly different from the maximal efficiency of 1 (p-value = 0.000). In treatment 1, the initial efficiency is close to 100%, but as time goes on it reduces to an efficiency of 71%. There is no significant difference between the initial and asymptotic efficiency in treatment 2 (p = 0.2193) and 3 (p = 0.2477). Figure 11, 12 and 13 show the median efficiency across periods in all treatment 1, 2 and 3, respectively.[25]

Figure 11
Time path for median efficiency of all 12 sessions of the SHILB treatment across period

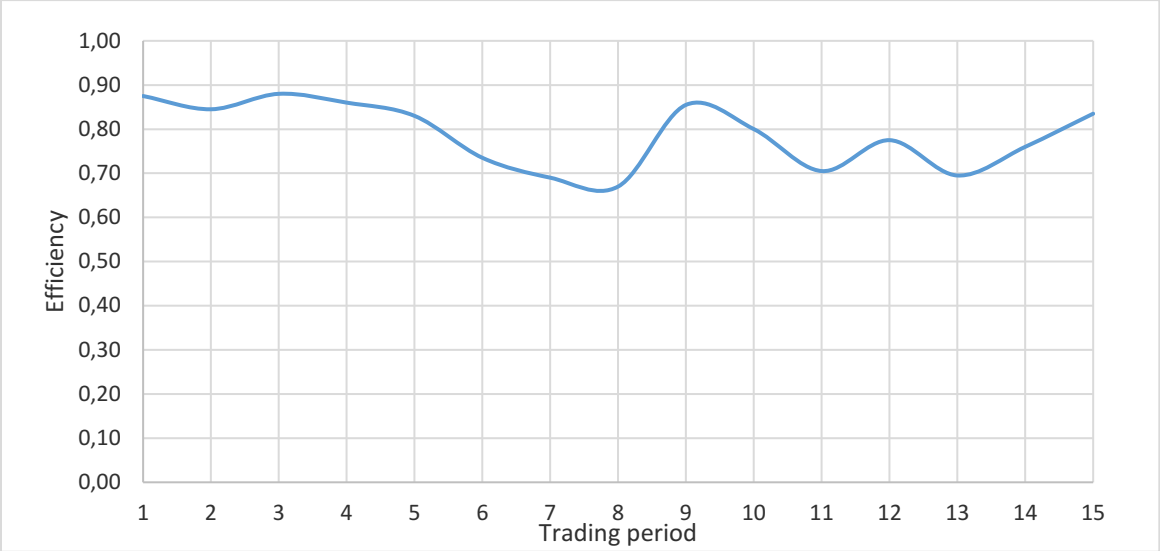
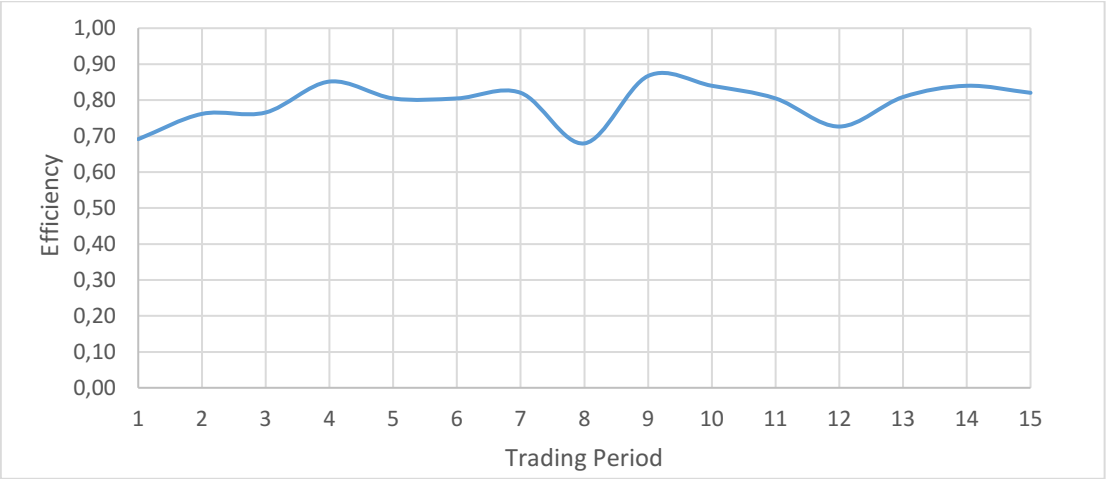
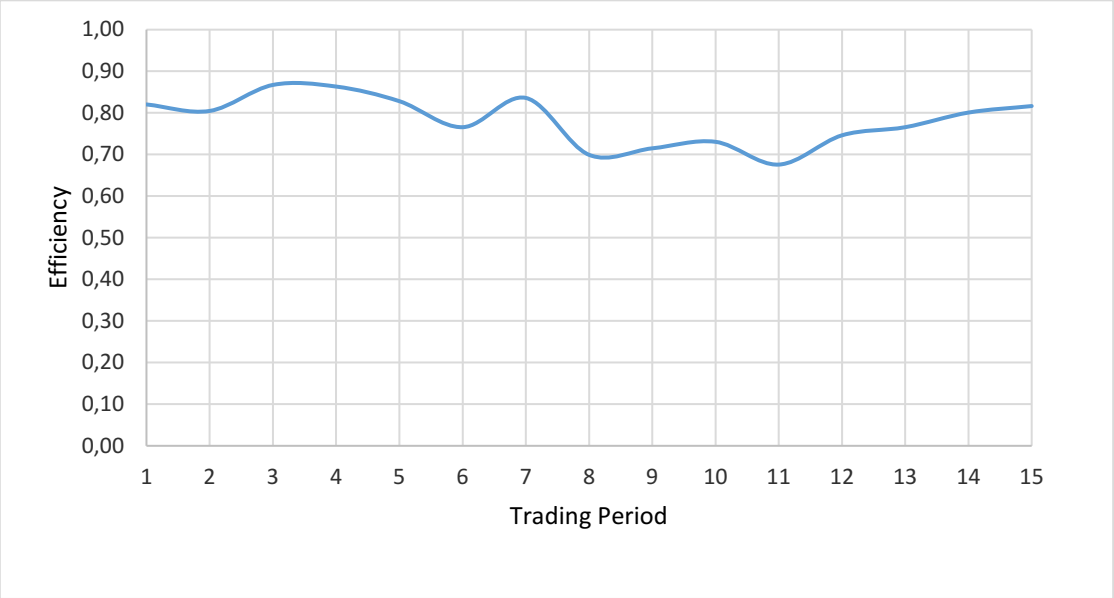


Figure 12
Time path for median efficiency of all 12 sessions of the SHB treatment across period



[25]See Appendix D for graphs showing the observed efficiency by period of each of the twelve sessions of each treatment.

Figure 13
Time path for median efficiency of all 12 sessions of the ILB treatment across period



Hypothesis 3: Political bias in the price-setting committee has an effect on efficiency.

Result 3a: Efficiency does not converge to the maximal efficiency in all three treatments.

Result 3b: Average efficiency are similar in all three treatments

3.4. Bias Effect on Profit Distribution

Table 8 shows the period median of the sellers and buyers profit as a percentage of the total surplus for the three treatments.[26] It is the total earnings of all sellers/buyers, as a percentage of total surplus.[27] Theoretically at the competitive equilibrium price sellers are predicted to earn 62.5% of the total possible gain, and buyers 37.5%. Meanwhile, at a price of 30, the lowest price that allows for an efficient allocation, sellers are predicted to earn 15.6% of the total possible gain, and buyers 84.4%. In all three treatments, sellers tend to earn less than and buyers more than their predicted share at the competitive equilibrium.

[26] Profit as a percentage of total surplus = ($\frac{Observed\ profit}{theoretical\ profit}$) *100

[27] It can also be referred to as buyers´ surplus share/ sellers´ surplus share

Table 8
Median of profit as a percentage of total surplus

	SHILB		SHB		ILB	
Session	Sellers	buyers	Sellers	buyers	Sellers	buyers
1	15.6	48.4	53.1	14.8	5.5	68
2	5.5	40.6	53.1	35.9	45.3	41
3	40.6	45.3	0	93.8	20.3	45.3
4	31.2	67.2	64.8	16	27.3	49.2
5	20.3	41	64.8	16	42.2	32.8
6	12.5	65.6	54.7	22.6	15.6	32.4
7	30	58.6	0	22.6	15.6	29.3
8	14.1	48.4	13.3	45.3	11.7	56.6
9	27.3	51.6	53.1	31.2	70.3	10.9
10	26.6	34.4	50.8	32.8	31.2	53.5
11	22.7	41.8	34.4	45.3	24.2	46.5
12	46.9	37.5	37.8	21.9	10.9	52.3

Sellers´ surplus as a percentage of total surplus is highest in treatment 2 (SHB). In this treatment sellers earn on average 15.65% more than in the first treatment (Wilcoxon signed-rank test, N=12, p = 0.0995), and 13.30 % more than treatment 3 (Wilcoxon signed-rank test, N=12, p = 0.0712). On the other hand, buyers´ surplus as a percentage of total surplus is highest in treatment 1 (SHILB). In this treatment buyers earn on average 15.2% more than in the second treatment (Wilcoxon signed-rank test, N=12, p = 0.0499), and 5.21% more than treatment 3 (Wilcoxon signed-rank test, N=12, p = 0.0995). These results are not surprising, as due to the makeup of the price setting committee, a buyer's coalition is plausible. In addition surplus share is evenly distributed between buyers and sellers in the SHB treatment (Wilcoxon signed-rank test, N=12, p = 0.3264), and in the ILB treatment (Wilcoxon signed-rank test, N=12, p = 0.7240). Thereby rejecting the hypothesis of no effect of the composition of price committee on buyers profit distribution.

Hypothesis 4: Political bias in the price-setting committee has an effect on profit distribution.

Result 4a: Consumers surplus as a percentage of total surplus is higher in SHB than SHILB.

Result 4b: Consumers surplus as a percentage of total surplus is higher in SHB than ILB.

Result 4c: Consumer surplus as a percentage of total surplus is higher in SHILB than ILB.

Result 4d: Producers surplus as a percentage of total surplus is higher in SHILB than SHB.

Result 4e: Surplus share is evenly distributed between consumers and producers in the SHB and ILB treatment.

Result 4f: Surplus share is not evenly distributed between consumers and producers in the SHILB treatment.

4. Conclusion

Laboratory results reveal that bias in the constitution of the price-setting committee of a socialist market has an effect on the trade price and profit distribution, but no effect on efficiency and the number of trades. When the committee is made up of high-value buyers and sellers trade price is the highest. This is expected as sellers benefit from high prices and high-value buyers are not as negatively affected by the high prices as lower value buyers. However, efficiency is not affected by politically bias in the price-setting committee. It goes to show that efficiency loss is an inherent attribute of a socialist market.

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APPENDIX

Appendix A – Instructions for the Socialist Experiment (translated from German)

General Instructions

Welcome! This is an experiment on decision-making. You will be paid €4 for showing up. If you carefully read the instructions and follow rules you can earn additional money. The €4 and all other money earned during the experiment will be paid to you in cash immediately after the experiment. In the experiment you earn points. These points will be exchanged for Euros according to the following exchange rate: 1000 points = €3.You are not allowed to speak to other participants during the experiment. If you have a question, please ask us. We will gladly answer your questions individually. It is very important that you follow these rules.

In this experiment, we are going to simulate a market of a commodity in which some of you will be buyers and some of you will be sellers. The commodity to be traded is divided into distinct units. We will not specify a name for the commodity; we will simply refer to them as units. You will use the computer to buy or sell. The market consists of 8 participants, including you. Of the 8 participants, 6 are buyers and 2 are sellers. Whether you are a buyer or seller will be decided randomly.

The experiment has 2 practice periods followed by 15 trading periods. In the practice periods, you do not earn money but you should take these periods seriously since you will gain valuable experience for the trading periods that are paid. Each period last 2 minutes and is made up of two phases, the price decision phase (up to 80 seconds) and the trading phase (up to 40 seconds).

During the price decision phase a pricing committee has to decide on the price at which a unit of a commodity should be bought and sold. The pricing committee will be made up of four participants (one seller and three buyers) randomly chosen at the beginning of the experiment. These four participants will be members of the pricing committee for all the trading periods. There will be information on your computer screen telling you if you are a member of the pricing committee or not. In the price decision phase, every member of the pricing committee may propose prices. These prices will be visible to all members of the pricing committee. Each member can change their proposal by entering a new price. The first price that is suggested by two members is the trading price for that period. If a price has not been decided by the pricing committee by the end of the price decision period a trade price will be randomly assigned.

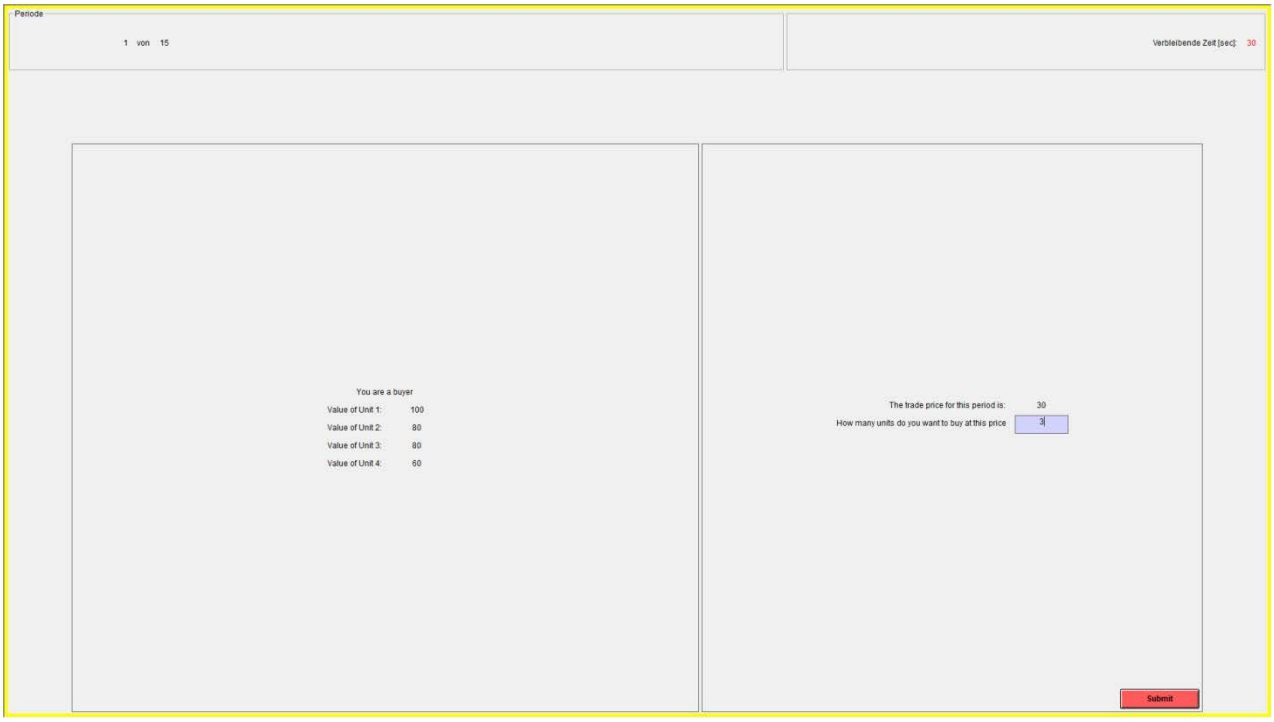
The trading phase begins after the price decision phase. The trade price for the period is announced to all buyers and sellers. Each buyer (seller) indicates the number of units they are willing to buy (sell) at that price. If demand and supply match then sellers and buyers orders are completely fulfilled. In case of undersupply buyers are rationed (buying orders are cut at

random to equate to supply) and in case of oversupply, sellers are rationed (selling orders are cut at random to equate demand). The trading phase ends after 40 seconds and sellers and buyers are informed of their purchases.

Detailed Instructions for Buyers

In this experiment you are a buyer

As a buyer, you will be assigned four units of the commodity with different values. These values will be displayed on your screen as shown below



In this example that the value of the first unit is 100 points and the second unit is 100 points etc. (note that your actual values may differ from this example).

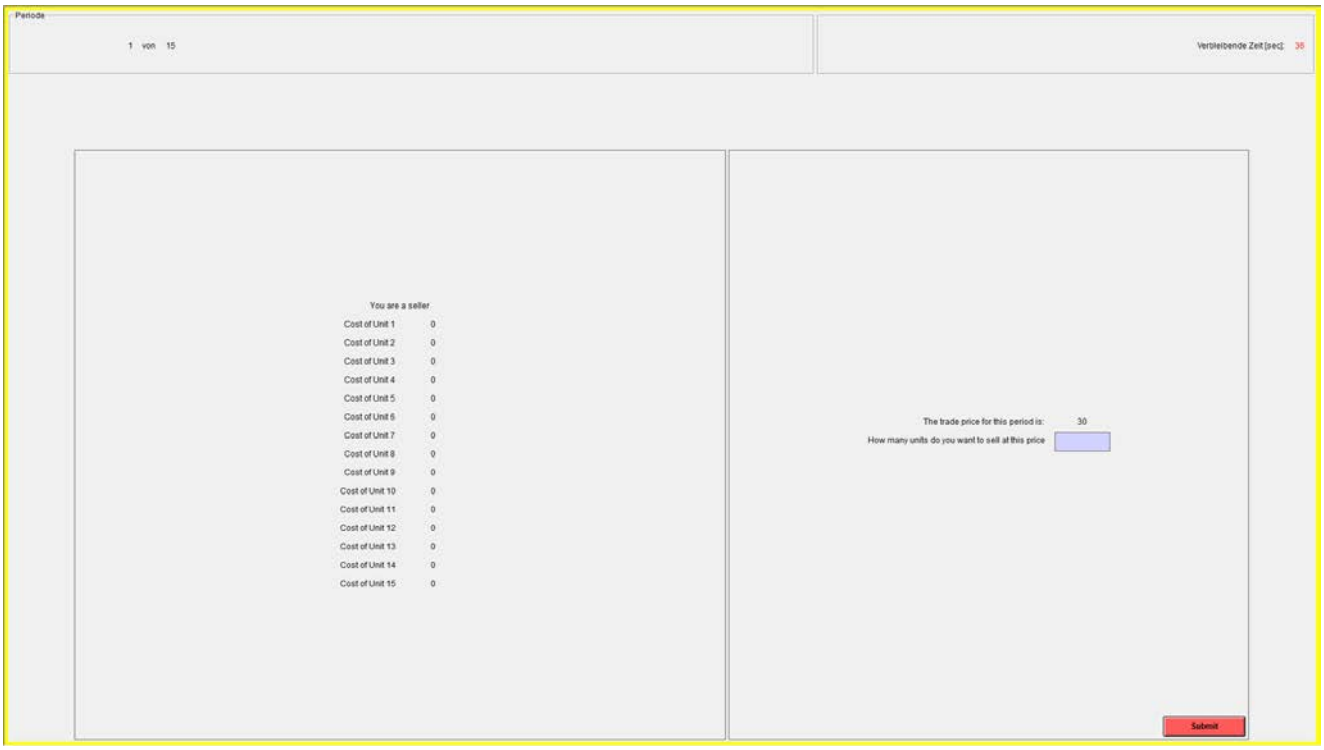
After the price decision phase is over the trade price will be displayed on your screen. You can buy up to 4 units at this price. To do so, enter the number of units you want to buy and then click “submit”. If demand and supply match then all orders are completely fulfilled and you will receive all the units you requested. In case of undersupply buyers are rationed (buying orders are cut at random to equate to supply). In this case you might not buy all the units you wanted to buy.

Your profit as a buyer is computed as follows:
Profit of Unit 1 = value of unit 1 minus the trade price
Profit of Unit 1 = value of unit 1 minus the trade price
Example: Suppose the value of your first unit is 100 and you bought it for 60. Your profit will be: 100 - 60 = 40. In addition, you earn profit on other units you may have bought. It is important to note that you can also make losses. If you bought a unit having value 80 at a price of 90, your profit will be: 75 - 90 = -10. So you make a loss of 10. At the end of each trading period, you will be shown a screen with the profit you made during that period.

Detailed Instructions for Sellers

In this experiment you are a seller

As a seller, you will be assigned 15 units of the commodity with different cost. These costs will be displayed on your screen as shown below:



In the example above, the cost of your first unit is 10points and the cost of the second unit is 10 points, etc. (note that your actual costs may differ from this example).

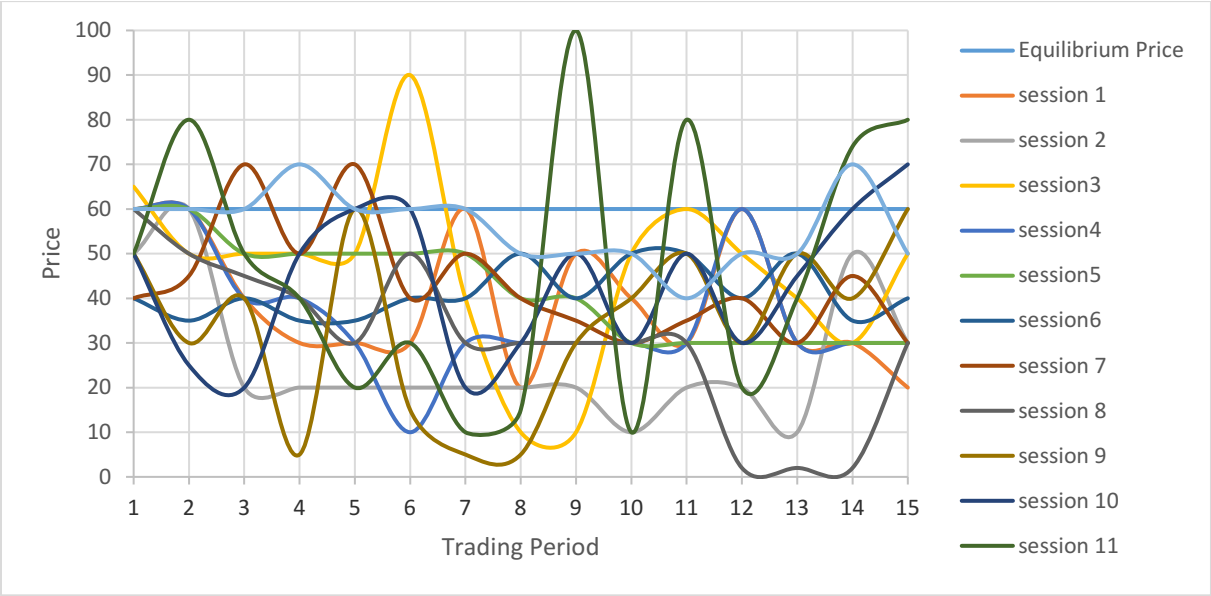
After the price decision phase is over the trade price will be displayed on your screen. You can sell up to 15 units at this price. To do so, enter the number of units you want to sell and then click “submit”. If demand and supply match then all orders are completely fulfilled and you will sell all the units you requested to be sold. In case of oversupply sellers are rationed (selling orders are cut at random to equate to demand). In this case you might not sell all the units you wanted to sell.

Your profit as a producer is computed as follows:

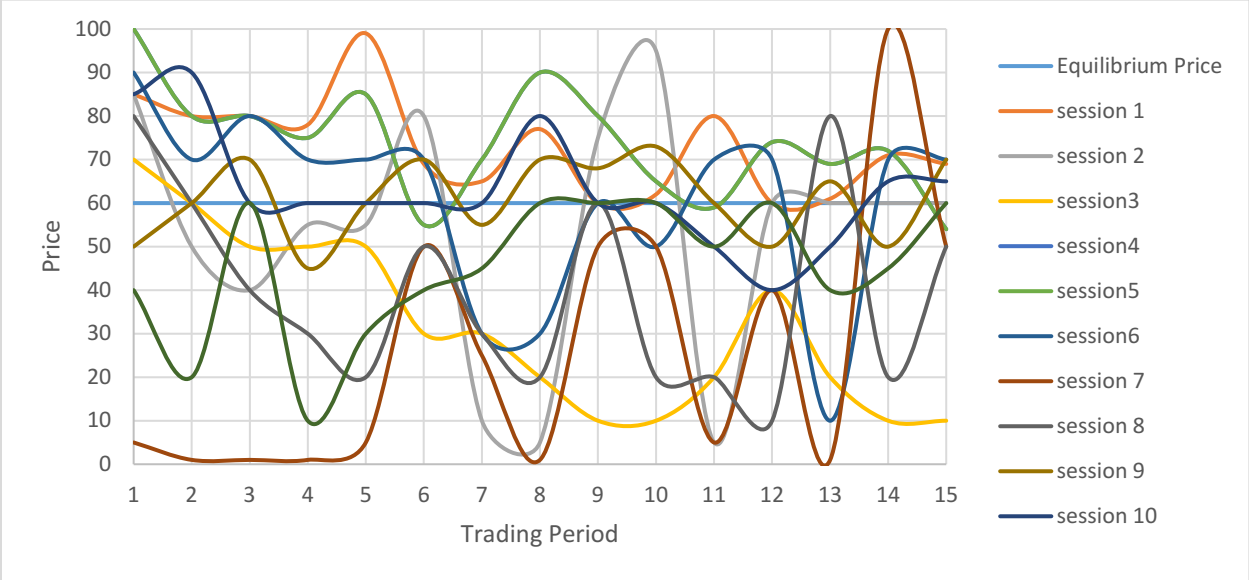
Profit of Unit 1 = the trade price minus cost of unit 1
Profit of Unit 1 = the trade price minus cost of unit 2
Example: suppose the cost of your first unit is 10 and you sold it at 40. Your profit will be: 40 - 10 = 30. In addition you earn profit on other units you may have sold. It is important to note that you can also make losses. If you sold a unit that costs 10 for 5, your profit will be: 5 - 10 = -5. So you make a loss of 5.At the end of each trading period you will be shown a screen with the profit you made during that period.

Appendix B

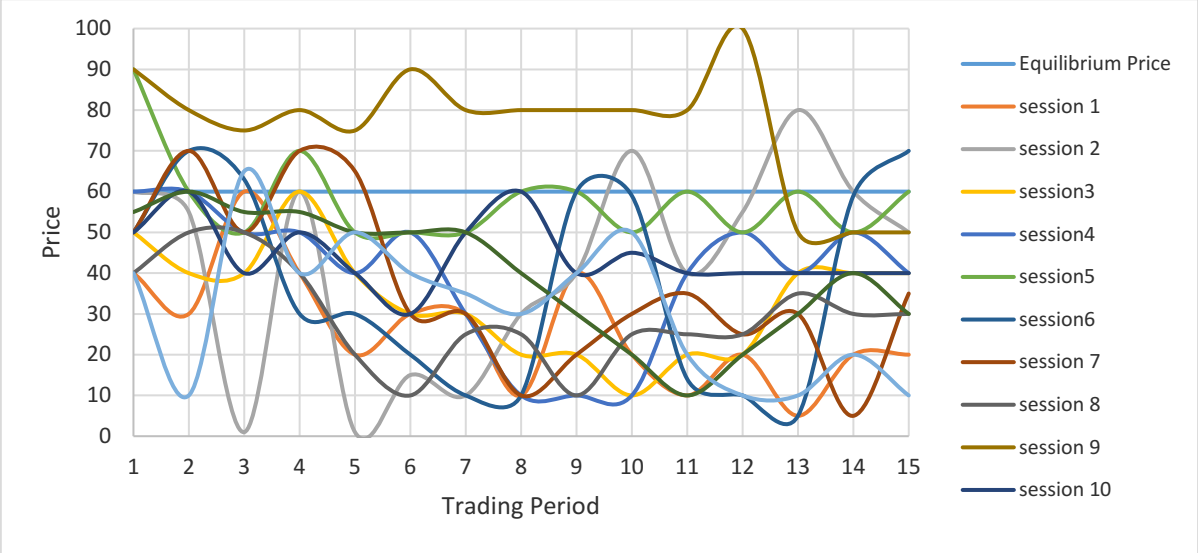
Time path of trade prices for the 12 sessions of the SHILB treatment across trading periods



Time path of trade prices for the 12 sessions of the SHB treatment across trading periods

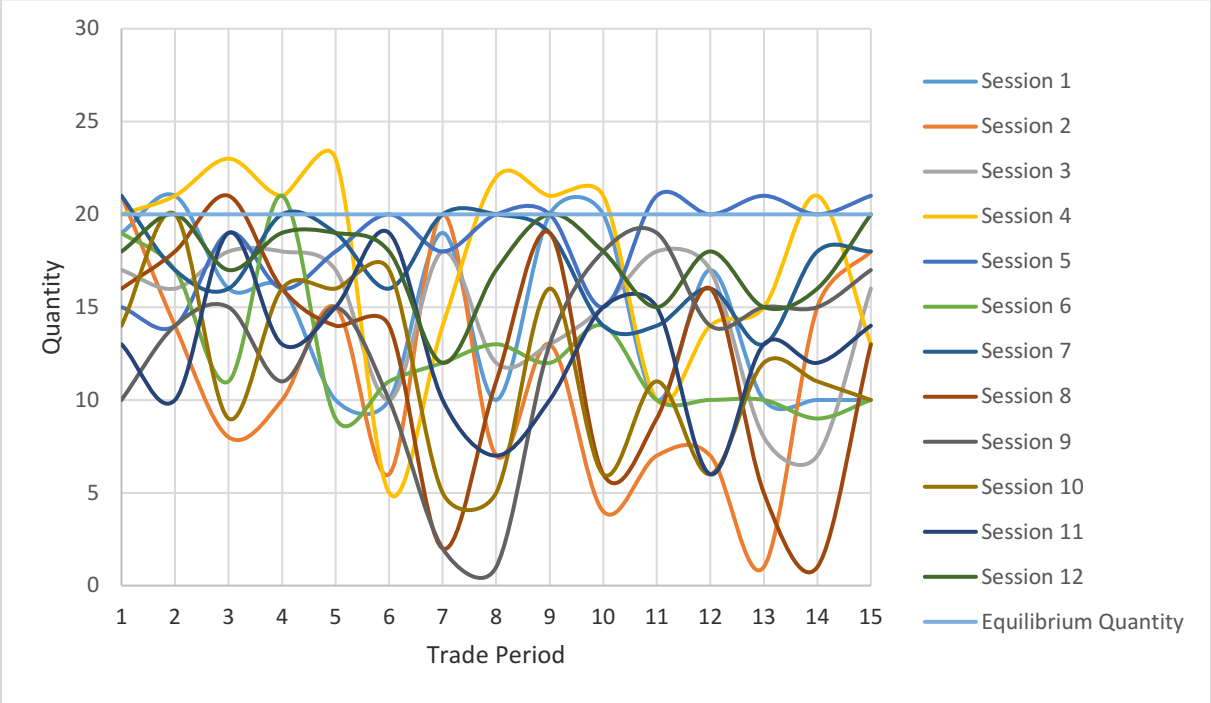


Time path of trade prices for the 12 sessions of the ILB treatment across trading periods

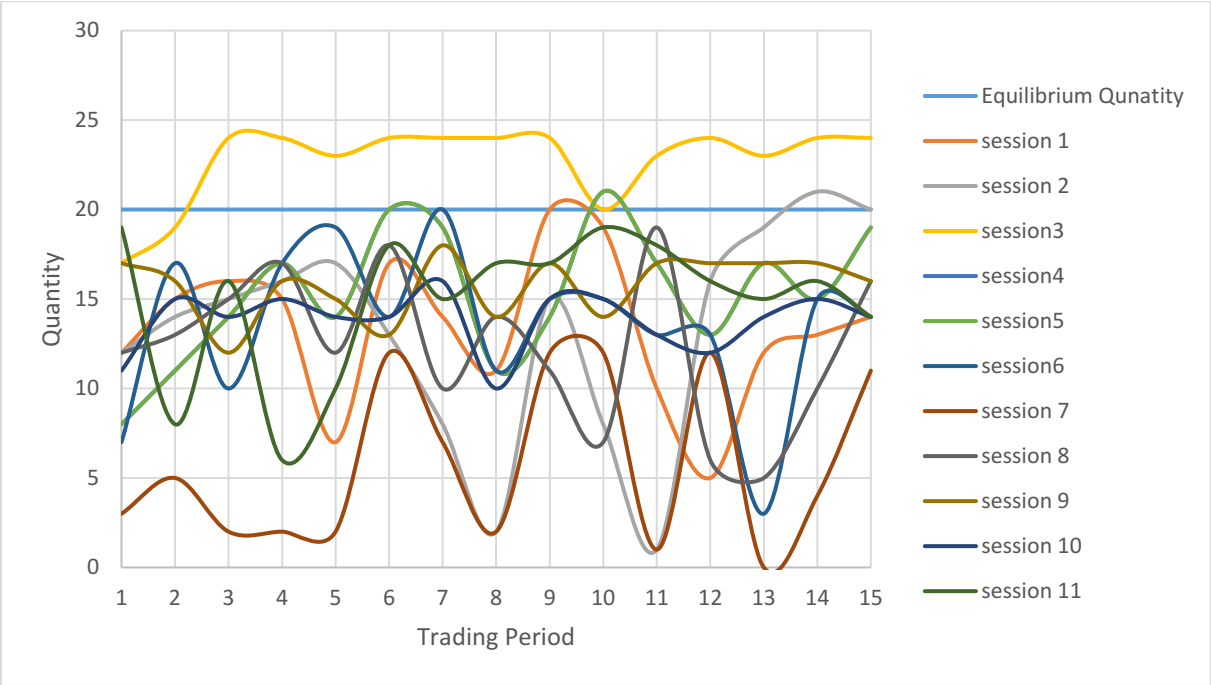


Appendix C

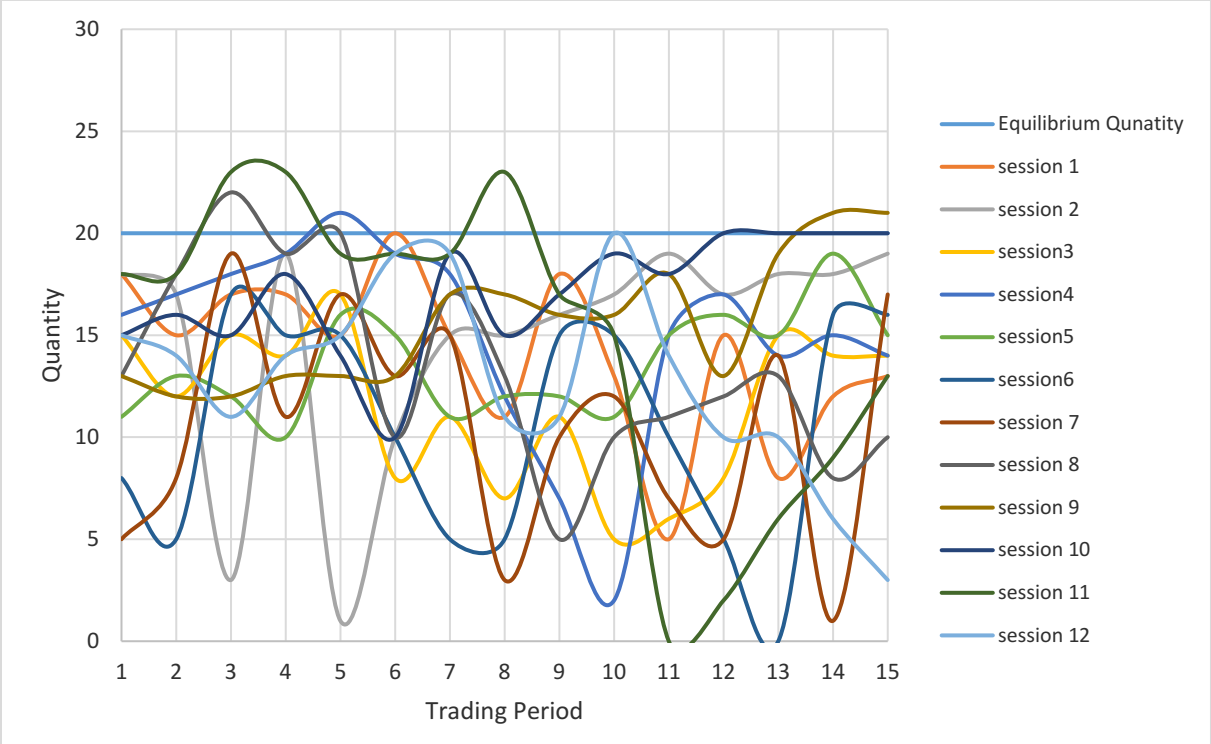
Time path of trade quantity for the 12 sessions of the SHILB treatment across trading periods



Time path of trade quantity for the 12 sessions of the SHB treatment across trading periods

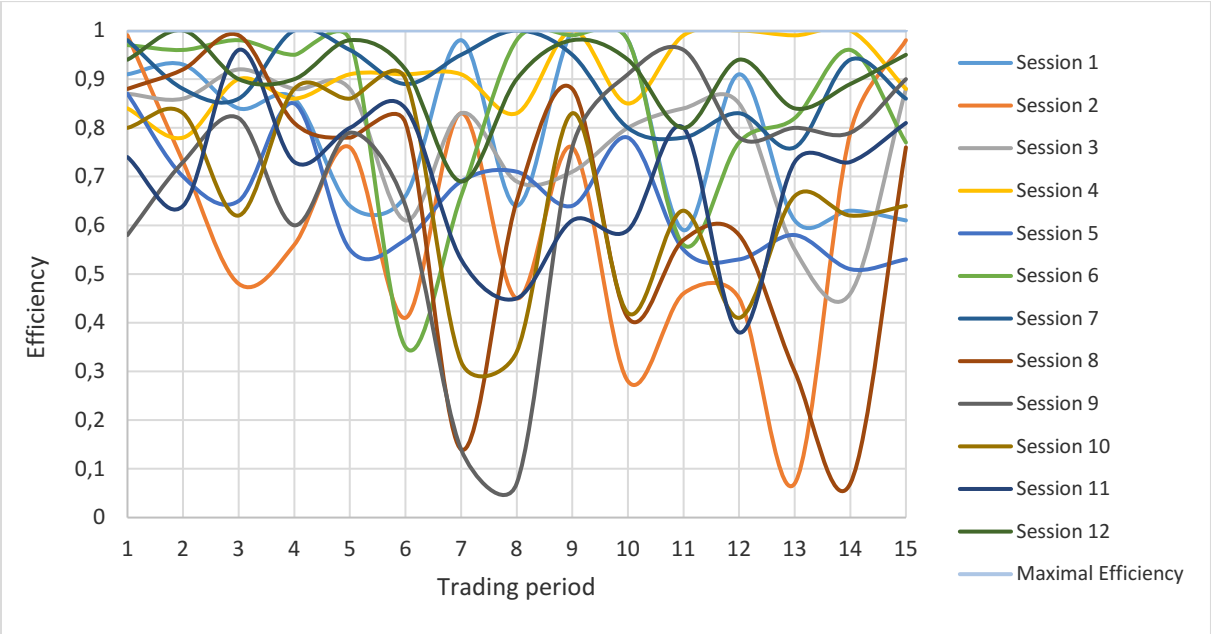


Time path of trade quantity for the 12 sessions of the ILB treatment across trading periods

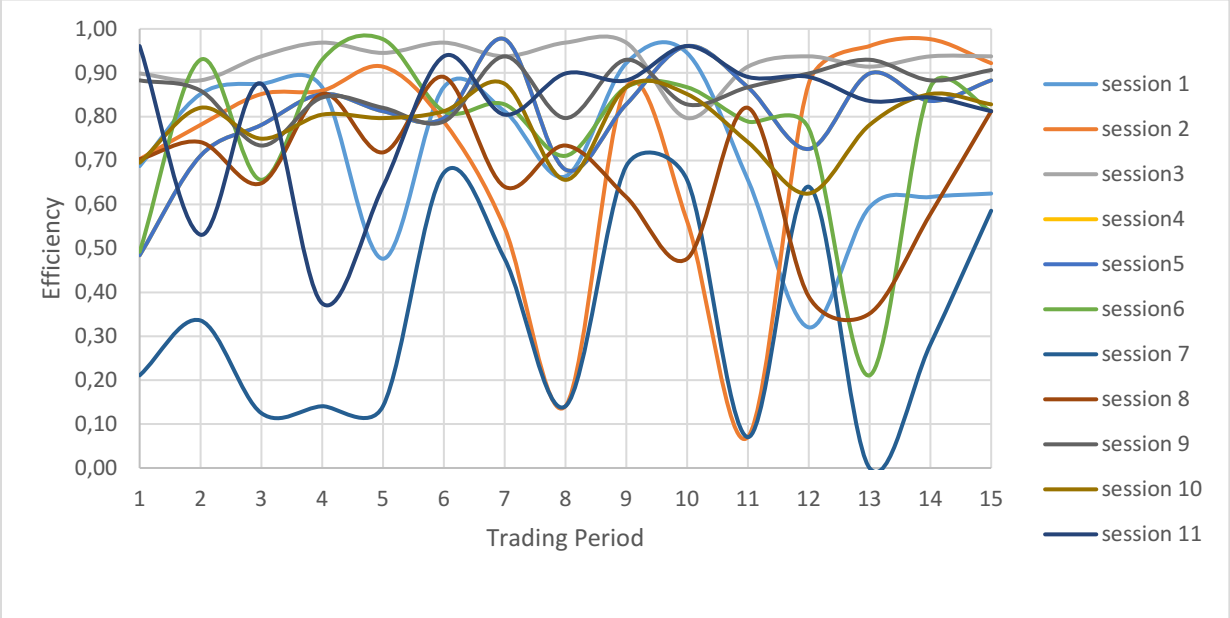


Appendix D

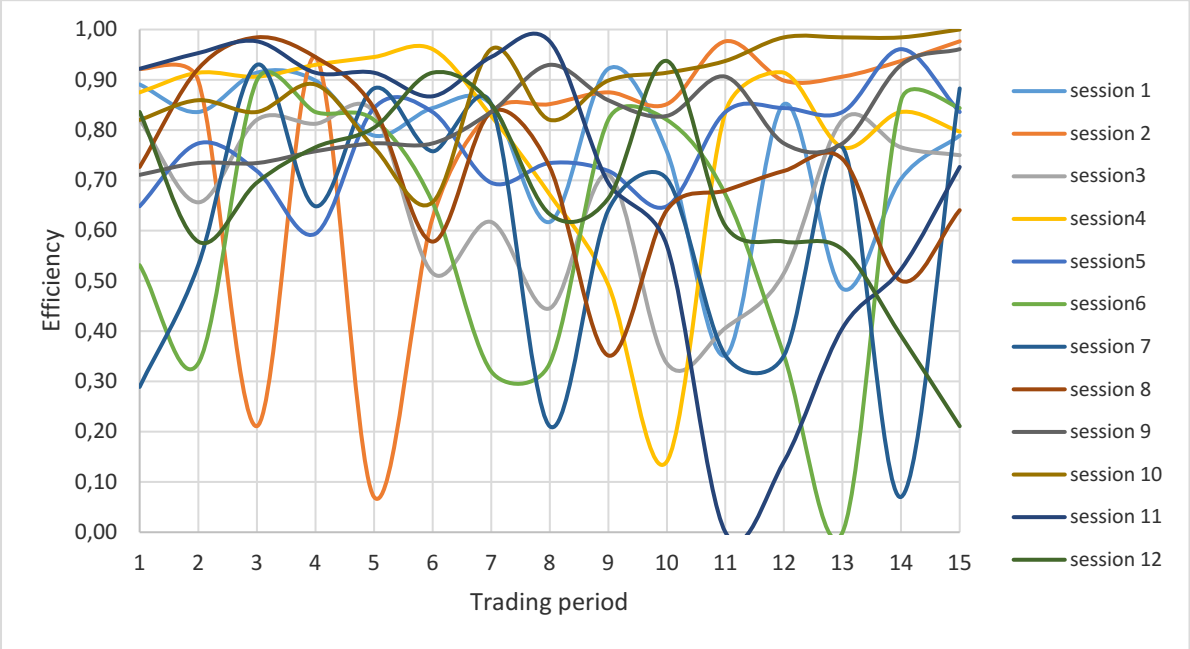
Time path of efficiency for the 12 sessions of the SHILB treatment across trading periods



Time path of efficiency for the 12 sessions of the SHB treatment across trading periods



Time path of efficiency for the 12 sessions of the ILB treatment across trading periods



PAPER 3:
Female Labour Force Participation in Urban and Rural Cameroon - An Empirical Analysis

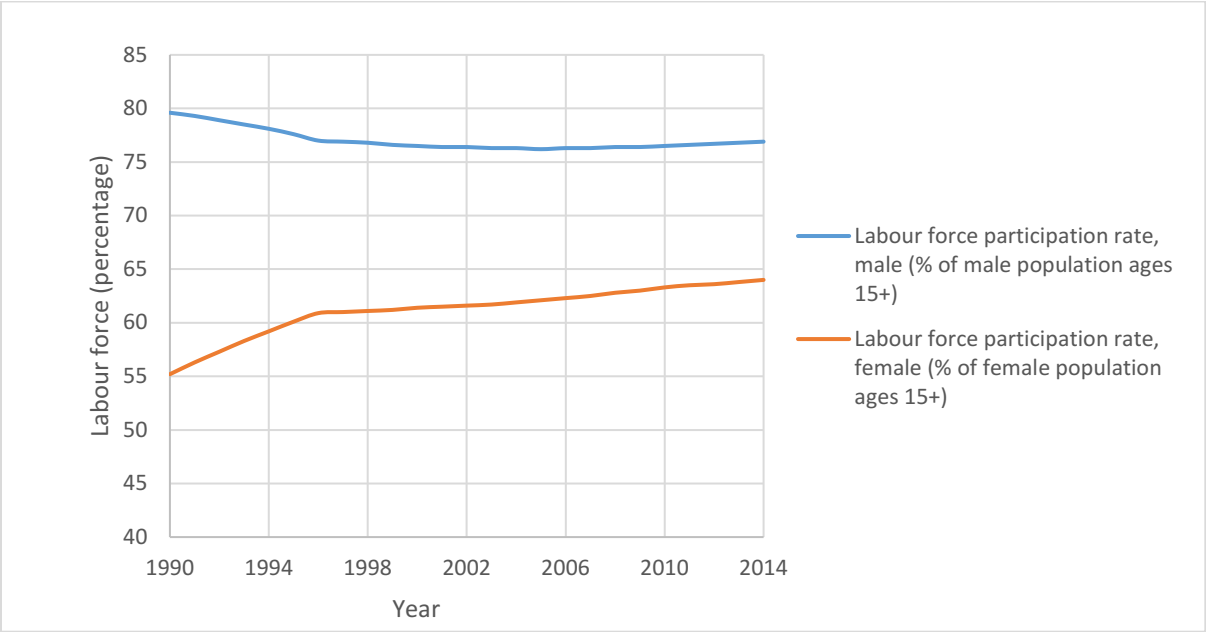
Abstract

This study analyses cross-sectional data pooled from the 1991, 1998, 2004 and 2011 Demographic and Health Surveys to estimate the determinants of labour force participation in urban and rural Cameroon. Descriptive analysis revealed that in this dataset 64% of urban women and 79% of rural women were working. Binomial logit regression analysis revealed that some of the statistically significant determinants of FLFP in urban and rural Cameroon are age, number of children in the household ages 5 and under and region of residency. Marital status was also a key predictor in rural, but not urban Cameroon. One striking result was that although not significant, educational attainment level was negatively related to FLFP. The results also reveal that there is an urban/rural residency gap in FLFP. To explore this further I employ a decomposition analysis. The decomposition analysis reveals that only 36% of this difference is accounted for by differences in the characteristics of women in the urban compared to their counterparts in the rural areas.

1. Introduction

Several countries have experienced a rise in female labour force participation, FLFP thereafter, over the last few decades. This is also true for Cameroon as observed in Figure 1. Figure 1 shows the evolution of labour force participation rates of men and women in Cameroon from 1990 to 2014[28]. The graph shows that while the male participation rates have declined, the participation rates of women has increased, thereby narrowing the gender gap in employment. However, despite the improvement, much still needs to be done, because there is still a sizable gender gap in employment.

Figure 1
The evolution of labour force participation rates in Cameroon, women vs men, 1990-2014



Source: Worldbank.org

The behaviour of FLFP has implications for male-female wage differential, marriage, fertility and the demand for child care facilities (Benjamin, Gunderson, Lemieux, & Riddell, 2012; Killingsworth & Heckman, 1986). In addition, women´s participation in the labour market promotes various types of gender equality in society and in the home, which in turn boosts economic development (Goldin, 1995). Hence, understanding the factors that affect a woman´s decision to work is important for policy makers. The awareness of researchers on the importance of female participation in the labour market is evident by the extensive

[28]Labour force participation rate is the proportion of the population ages 15 and older that is economically active. The labour force participation rates presented here are the International Labour estimates from the International Labour Organization´s Key Indicators of the Labour Market database and may differ from national estimates. The series includes both nationally reported and imputed data.

research that has been done in this area of economics. However, even though FLFP has been studied extensively, there are only a few studies so far that have tried to identify the determinants of FLLFP in Cameroon. This study seeks to fill that research gap.

In Cameroon, people living in urban areas have access to more job opportunities than those in the rural areas. This is due to the fact that urban areas are more economic developed. On the other hand, rural residency provides women with the opportunity to combine child rearing and working because agriculture, the main source of income in the rural areas, allows for this. With that in mind, I will also investigate the determinants of FLFP for urban and rural Cameroon separately.

The objective of this study is three folds. Firstly, to identify the determinants of FLFP in Cameroon. Secondly, to investigate if these factors differ between rural and urban Cameroon.[29] Finally, I give a brief overview of the trends in female and male labour force participation in Cameroon between 1998 and 2011.The analysis in this paper provide policy makers with useful estimates on female labour supply in Cameroon. The rest of the paper is organized as follows: section 2 focuses on the economic theory of labour supply, section 3 presents a brief review of related literature. In section 4 I discuss the data source followed by section 5 that focuses on methods used in this study. In section 6 I present the main results and finally section 7 concludes.

2. Theoretical Background

This section briefly discusses two theoretical labour supply models[30].

2.1. The Basic Model of Labour Supply

This section discusses the basic neoclassical model of labour supply[31],which is based on basic consumer theory. It is a static within-period model that evaluates how individuals decide to share their time between working and leisure. Leisure is defined as time spent in non-market activities (Cahuc, Carcillo, &Zylberberg, 2014). Following Killingsworth and Heckman (1986), consumers seek to maximize their utility (satisfaction) function

[29] Urban includes cities and towns, and rural includes villages.
[30] For a discussion on several other important labour supply models see Blundell &MaCurdy (1999); Cahuc et al., (2014); Gronau(1986);Killingsworth& Heckman (1986); Pencavel (1986) just to mention a few.
[31]For a detail explanation of the basic model of labour supply, see Borjas (2016);Benjamin et al (2012); Cahuc et al (2014) just to name a few.

$$U\ (C, L) \tag{2.1}$$

subject to a budget constraint

$$C = wT + I - wL\ , \tag{2.2}$$

Where C is consumption[32], L is leisure hours, w is the wage rate, T is the total time available, I is the income obtained from nonlabour work and wL is the price of leisure (the opportunity cost of forgone labour from not working).

The Lagrangianfunction is as follows:

$$\varphi = U(C, L) - \lambda(C - wT - I + wL) \tag{2.3}$$

where λ is the Lagrange multiplier.

The first order conditions are

$$U_C(C, L) = \lambda$$

$$U_L(C, L) \geq \lambda w,\ with\ > when\ T = L \tag{2.3}$$

where λ is the marginal utility of income, U_C is the partial derivative of U with respect to C and U_L is the partial derivative of U with respect to L.

Solving the first order condition (2.3) gives

$$\frac{U_L}{U_C} \geq w \tag{2.4}$$

The interior solution, where by the equality holds, indicates that the individual is participating in the labour market. In other words, hours of leisure, L, is less than total available time, T. An individual is not working if the inequality in (2.4) holds (corner solution). That is T = L. A person´s decision to work or not, is based on a comparison of the market wage, which indicates how much employers are willing to pay for an hour of work, and the reservation wage, which indicates how much the worker requires to work (Borjas, 2016 p. 41). An

[32] In this model, savings are ignored, so the value of consumption goods, is equal to labour and non-labour income (Benjamin et al., 2012 p.40).

individual's reservation wage is the wage, such that $U_L(C, L) = \lambda w$ (Blundell and MaCurdy, 1999). A person enters the labour market when their reservation wage is less than the market wage. So the labour force participation rate corresponds to the proportion of individuals whose reservation wage is less than the market wage (Borjas, 2016; Cahuc et al., 2014).

An increase in non-labour income, I, will lead to a reduction in the number of hours worked, and vice versa. The effect a change in nonlabour income has on hours worked is known as the income effect (Borjas, 2016). A change in an individual's wage rate has two effects on their working hours. A higher wage will lead to a decrease in working hours because the individual earns more income which can be spent on purchasing more goods and leisure time. This is the income effect. Also, an increase in wage rate can result in the individual working more because leisure time becomes more expensive. This is the substitution effect. The direction in which hours worked changes in response to a change in wage rate depends on the strength of the income and substitution effects. An increase in the wage rate increases work hours if the substitution effect is greater than the income effect, and vice versa. No matter how much the income effect is greater than the substitution effect, an increase in wage can never result in an individual reducing their working hours to zero (that is not participating in the labour market). On the other hand, an increase in wage might result in an individual entering the labour market. For individuals who do not participate in the labour market, an increase in wage has only a substitution effect (Borjas,2016).

2.2. Household Production Model

One shortcoming of the neoclassical model of labour supply is that, it does not take into consideration the different activities outside of work, instead, it considers all activities outside of work as leisure. However, leisure is not the only alternative to wage work. Another aspect the traditional theory of labour supply neglects is that decisions about labour supply are family decisions (Cahuc et al., 2014).

Gary Becker´s 1965 seminal paper on the theory of the allocation of time addresses these shortcomings. The main assumption of this theory is that households are both producers and consumers. According to Becker (1965), a family´s utility is not received directly from its consumption of market goods, as the traditional theory suggest. Instead, by combining goods purchased from the market and time supplied by each family member, the family produces commodities which are the family´s utility. Hence family utility is a function of a vector of

nonmarketable, home-produced commodities for example entertainment, good health, nutrition, satisfaction from children etc. (Willis, 1973)

In Becker´s model time is allocated across three basic activities namely, wage work, household work and leisure and the family and not a single individual maximize utility. In multi- person households the decision about which members does wage work or household work is determined by their efficiency in wage or household work (specialization). In most cases women are more efficient in household work than men, so women are more likely to trade off wage work for household work and a high proportion of their husbands would then trade leisure and household work off for wage work (Becker, 1985; Cahuc et al., 2014). However, nowadays, due to the availability of time-saving household appliances like microwaves, washing machines, and dish washers, less time is needed to produce household commodities (Borjas, 2016) and as a result, women have more time to engage in the labour market. This technology also lessens the need for specialization and thus further contributes to an increase in FLFP (Borjas, 2016).

3. Literature Review

The empirical literature on FLFP is extensive and will not be completely reviewed here[33]. The literature on female labour supply has evolved differently from that on male labour supply. When it comes to women, research has focused on modelling their participation decision (Keane, 2011).[34] In this section, I will briefly review the literature on the trends in FLFP and the determinants of FLFP.

3.1. Trends in Female Labour Force Participation

Research suggests a U-shaped model of trends in female labour supply with economic development (Goldin, 1995: Kottis, 1990; Psacharopoulos & Tzannatos, 1989). According to the U-shaped hypothesis, in the initial stage of development when agriculture is the dominant source of income, women participation in the labour market is high. They mostly work in family businesses where work and household duties can be combined. As the economy grows and the industrial sector replaces the agricultural sector, FLFP is at its lowest. This is due to

[33] For reviews of female labour supply studies see for example Keane (2011); Killingsworth (1983); Killingsworth & Heckman (1986).

[34] On the other hand, research on male labour supply have instead focused on continuous choice hours and emphasized savings as the main source of dynamics. This is due to the fact that the majority of adult males work and hence selection bias caused by ignoring males who do not work is minimal (Keane, 2011 p. 1045).

the fact that the dominant industrial sectors have a greater demand for male than for female workes. As the economy grows even further, women become highly educated, fertility declines and so there is a rise in FLFP. However, some researchers do not support this U-shaped hypothesis. Durand (1975) states that although female labour supply in agriculture tends to diminish with initial economic growth, the hypothesis does not hold true for developing countries. In addition, Standing (1978) argues that the variations in rural and urban FLFP are too wide to be properly described by the U-Shaped hypothesis. Steel (1981) found that contrary to the hypothesis, FLFP rose instead of fell when Ghana experienced a rapid growth in manufacturing employment in the 1960s.

3.2. Determinants of Female Labour Force Participation

Based on the prediction of economic theory, variables that increase market wage will positively influence FLFP, whereas variables that increase reservation wage will negatively influence FLFP (Benjamin et al., 2012). The effect of a woman´s education, her age, marital status, and the number of children she has on her labour supply decisions have been extensively studied. In this subsection, I report a few of the variables that have been consistently found to influence FLFP.

3.2.1. Education Attainment

Several studies have identified educational attainment as one of the main determinants of FLFP.[35] Education is hypothesized to positively affect FLFP. This relationship can be explained by the fact that education increases the opportunity cost of staying out of the labour market (Bowen & Finnegan, 1969, Mincer, 1975) and education is associated with a preference for working (Benjamin et al., 2012, Mincer, 1975).

3.2.2. Marital Status

The marital status of a woman has also been shown to influence her decision to work or not. Married women are less likely to work than their single counterpart, because of their homemaking responsibilities (Bowen & Finegan, 1969 p.23). Psacharopoulos and Tzannatos (1993) found that in 15 Latin American countries, marriage reduces the probability that a woman will work by half.

[35] See Eckstein & Lifshitz (2011); Euwals, Knoef,& van Vuuren (2011); Franz (1985); Psacharopoulos & Tzannatos (1991)

3.2.3. Fertility

Mincer (1962) analyzed the labour force participation of married women using 1950 Census data on 57 largest Metropolitan Areas in the North of the United States. He concluded that the number of children a woman has significantly affects her labour supply. Several other studies have found the same effect.

3.2.4. Age

Rearing children requires time so, women in childbearing age will have a lower participation rate than those outside this age. However, this might not be the case for all countries. Psacharopoulos and Tzannatos (1989) point out that in Sweden and Finland the highest FLFP rates are in the age group 25-44. They go further to states that this might be because Scandinavian countries have well developed social legislation and provide not only maternal but paternal leave too, and so the negative impact of child bearing on female labour supply is not as strong.

3.2.5. Female Wages

Research consistently finds that the female wages positively influences FLFP. Mincer (1962) found that the effect of wives´ earning power are positively, and stronger than the effect of their husband's income. This is consistent with several other studies of different countries and datasets that found that FLFP increase as a reason female wages increase.[36] It is important to state that in accordance with the human capital theory, education is positively related to earning power (Mincer, 1975).

3.3. Previous Studies on the determinants of FLFP in Cameroon

Even though the determinants of FLFP has been extensively studied worldwide, unfortunately, this has not been the case for Cameroon. The lack of studies on the determinants of FLFP in Cameroon was the main motivation of this research. Using the Generalized Method of Moments, Forgha and Mbella (2016) find that dependency ratio, fertility, male labour force participation and per capita income are determinants of FLFP in Cameroon.[37] Using DHS 2011 data, Fika and Sokeng (2016) find age, religion, and ethnic group, and household size,

[36]Gustafsson &Jacobsson (1985) for Sweden; Hartog & Theeuwes (1985) for Holland; Jones, Manuelli & McGrattan (2015) for USA; Smith & Ward for USA (1985); Shimada & Higuchi (1985) for Japan.
[37] They use data from 1980 to 2014

relationship with the head of household, educational level, husband´s occupation, marital status and household´s standard of living to be significant determinants of a Cameroonian woman´s labour supply.

4. Data

4.1. Data Source

The data used in this study are Demographic and Health Surveys (DHS) obtained from the DHS program´s website.[38] Details on the survey procedures and sampling design are provided in the survey report of each year. Authorization to use the data was obtained from the DHS website by providing a summary of my intended study. The data set includes sample weights to control for over and under- representation of certain households and to scale up the sample to reflect the entire population. In this paper, I control for stratification and clustering to adjust my standard errors to prevent them from being under or overstated. I also use the sample weights in my estimation to make the estimate representative of the entire population.[39] Table 1 shows information on the surveys used in this paper. The four datasets are pooled together for analysis.

Table 1
Summary of Cameroon Demographic and Health Survey included in analysis

Year	Dates of Fieldwork	Number of households interviewed	Number of women aged 15-49 interviewed	Implementing Organization
1991	04/1991 - 09/1991	3538	3871	Ministry of Planning and Regional Development
1998	02/1998- 06/1998	4697	5501	Central Bureau of Censuses and Population studies
2004	02/2004- 08/2004	10462	10656	National Institute of Statistics
2011	01/2011- 08/2011	14214	15426	National Institute of Statistics

Source: DHS.

4.1. Variables Description

[38] See http://www.dhsprogram.com/
[39]This was done using the Stata codes provided by DHS.

4.1.1. Dependent variable

Respondent´s Employment Status: The dependent variable is a binary variable which takes the value 1 if a woman is employed, or 0 otherwise. Employed include the self-employed, those employed by someone and those employed by family workers.

4.1.2. Independent Variables

Age of respondent: Studies have shown that FLFP is influenced by a woman´s age. Age is coded into seven different dummy variables to determine the effect of different age groups on FLFP. Each group has a 5 year range: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49.

Marital status: Marital status is coded into three dummy variables: Single/ not cohabitating women, women in monogamous unions and women in polygamous unions. Single women also include widowed,separated and divorced women.

The highest level of education attended by respondent: The respondent highest level of education is captured through four dummy variables: women with no education, those with primary education, those with secondary education and those with higher education. Education is expected to have a positive effect on a woman´s participation in the labour force since the opportunity cost of not participating in the labour market is higher as education rises. In other words, higher education is associated with a higher market wage, hence an increased probability of working. Also, education may lower reservation wage (Benjamin et al., 2012).

Number of children aged 5 and under living in the household: In Cameroon, it is very common for children to live with another family member, other than their parents. So I consider all children living in the household, not just the respondent´s children. This variable is expected to be negatively related to FLFP because having small children increases reservation wage.

Current pregnancy status: This variable is dummy variable that takes the value 1 if a woman is currently pregnant and 0 otherwise.

Regions: In order to capture the cultural and economic differences that might influence FLFP, a dummy variable is created for each region of Cameroon. The Republic of Cameroon is divided into 10 regions. The ten regions are Adamawa, Centre, East, Far North, Littoral, North, Northwest, South, Southwest, and West.

Household head: This is a dummy variable that gets the value 1 if the respondent is a household head. Household heads will be more likely to participate in the labour market as they have the responsibility of supporting their family.

Survey year: Four dummy variables are used to control for the year when the survey was taken.

5. Methodology and Hypotheses

5.1. Binominal Logit Model

Due to the binary nature of the dependent variable, logistic regression is used to estimate the determinants of FLFP. The probability of a woman working is assumed to follow a logistic distribution with the following cumulative logistic distribution function:

$$P(FLFP = 1) = \frac{e^Z}{1+e^Z} \ , \ where\ Z = \ ß_0 + ß_1 X_1 + \cdots + ß_n X_n \quad (5.1)$$

Where X_i is the i^{th} independent variable and β_i are parameters of the model.

The odds ratio, defined as the ratio of the probability that a woman is employed P(FLFP=1) to the probability that a woman is not employed P(FLFP= 0), is :

$$Oddsratio = \frac{P(FLFP=1)}{P(FLFP=0)} = \ \frac{1+e^Z}{1+e^{-Z}} = e^Z, , where\ Z = \ ß_0 + ß_1 X_1 + \cdots + ß_n X_n \quad (5.2)$$

The odds ratio of X_i tells us how many times higher the odds of FLFP is if X_i increases by one unit. However, "it is problematic to interpret odds ratios as substantive effects, because they also reflect unobserved heterogeneity" (Mood, 2010 p. 67). To solve this problem I estimated average marginal effects (see Mood, 2010). The FLFP model is first estimated for the entire sample, and then for women in the urban and rural areas separately.

5.2. Decomposition Analysis

After estimating the binary model above, a multivariate decomposition analysis is done to investigate the occurrence of FLFP between women living in the rural areas and those in urban areas. To do this, I use a method similar to the Blinder-Oaxaca decomposition technique (Blinder,1973;Oxacaca,1973). The Blinder-Oaxaca decomposition was introduced by Blinder (1973) and Oxacaca (1973) and could only be applied to linear regression models. The technique uses output from regression models to decompose the observed difference in mean or proportion between two groups into two components : (1) a component attributable to

differences in characteristics between the groups (the explained component) and (2) a component attributable to differences in coefficients or effects (the unexplained component or coefficients effects) (Powers et al., 2011). The latter maybe due to discrimination or any other unobserved characteristics. Recently, it has been extended to nonlinear regression models (Yun, 2004; Fairlie 2005; Powers et al., 2011). In my analysis, I use the decomposition technique described by Powers et al.,(2011) using the Stata *mvdcmp* command. Mvdcmp is based on recent contributions on how to deal with path dependency, and identification problems associated with the choice of reference category when dummy variables are independent variables (Yun 2004, 2005b, 2008). This technique will allow me to quantify the urban-rural differential in FLFP, and to identify the extent to which this difference can be explained. In addition to an overall decomposition, I will also perform a detailed decomposition to assess the contribution of each independent variable to each of the two parts. Following Powers et al. (2011) the mean difference in Y (FLFP) between group A and B can be decomposed as:

$$\bar{Y}^A - \bar{Y}^B = \left[\sum_{i=1}^{NA} \frac{F(X_i^A \hat{\beta}^A)}{N^A} - \sum_{i=1}^{NB} \frac{F(X_i^B \hat{\beta}^A)}{N^B}\right] + \left[\sum_{i=1}^{NB} \frac{F(X_i^B \hat{\beta}^A)}{N^B} - \sum_{i=1}^{NB} \frac{F(X_i^B \hat{\beta}^B)}{N^B}\right] \quad (5.3)$$

5.3. Hypotheses

- Variables like age, marital status, education, the presence of small children in the, pregnancy, region of residency, being a household head influence FLFP in urban Cameroon.
- Variables like age, marital status, education, the presence of small children in the, pregnancy, region of residency, being a household head influence FLFP in rural Cameroon.

6. Results[40]

6.1. Descriptive Statistics

Table 2 shows the means of the variables used in this study, pooling all observations from 1991, 1998, 2004 and 2011. As shown in table 2, the total sample consisted of 23501 women, 10669 in the urban area and 12832 in the rural areas. The results reveal that FLFP was lower for the urban areas than for the rural areas. In my sample, 64% of urban women and 79% of rural women were employed. The more than 10% higher participation rates amongst rural

[40] See Appendix A for the Stata codes used for analysis.

women in comparison to their urban counterparts maybe attributed to a number of reasons. 1) Rural women are less likely to be in higher education than urban women. This means that the time urban women spend at school is use by rural women to work. 2) Urban married women are more likely to have husbands whose incomes are sufficient to meet the financial needs of the family, whereas rural women have to work in order to supplement the income brought in by their partners. 3) In rural Cameroon, agriculture, which allows women to balance family responsibilities and work, is usually the main economic activity, thereby allowing rural women to be able to participate in the labour market while still fulfilling their household duties.

Table 2 also shows that most of the women in my study fall within the age range of 20-39. For marital status, 78% and 86% of urban and rural women, respectively, were married or cohabitating. The result also shows that 32 %(18%) of women in the rural (urban) sample were in a polygamous union. This is not surprising as the polygamous union is more prevalent in rural than urban Cameroon. With regards to educational attainment, 16% and 42% of women in urban and rural areas, respectively, had attained no education. This urban/rural education difference was expected. The table also shows that the mean number of children 5 and under living in a household is approximately 2 for both urban and rural areas. The largest proportion of women reside in the center province, which is the capital province.

Table 2
Descriptive statistics

Variables	Pooled sample	Urban sample	Rural sample
	Mean	Mean	Mean
Employed	0.73	0.64	0.79
Age (years)			
15-19	0.07	0.06	0.08
20-24	0.19	0.19	0.20
25-29	0.21	0.22	0.20
30-34	0.17	0.18	0.17
35-39	0.15	0.15	0.14
40-44	0.11	0.11	0.11
45-49	0.10	0.09	0.10
Marital Status			
Single/ not cohabitating	0.17	0.22	0.13
Monogamous union	0.57	0.60	0.54
Polygamous union	0.26	0.18	0.32
Education			
No education	0.31	0.16	0.42
Primary	0.39	0.35	0.42
Secondary	0.28	0.44	0.15
Higher	0.02	0.04	0.00
Household head	0.13	0.18	0.09
Number of children in the household ages 5 and under	1.74	1.48	1.95
Currently pregnant	0.11	0.09	0.13
Regions			
Adamawa	0.10	0.10	0.11
Centre	0.21	0.26	0.17
East	0.08	0.06	0.10
Far North	0.16	0.08	0.22
Littoral	0.15	0.24	0.07
North	0.08	0.06	0.10
North West	0.07	0.06	0.08
West	0.07	0.08	0.07
South	0.02	0.02	0.03
South West	0.05	0.05	0.05
Observations	23501	10669	12832

Note: The descriptive statistics have been calculated using sampling weights provided by the DHS. The sample includes women aged 15 to 49.

6.2. Binomial Logit Model

To determine factors that influence FLFP in Cameroon, the binomial logit model (5.1) is estimated three times. Model 1 includes the entire sample, model 2 consist of women in the urban areas and model 3 consist of rural women. All analyses were weight adjusted for DHS

sampling strategy, to make it representative of the total population. Table 2 shows the estimates of the binomial logit model of the predictors of FLFP.

Table 3
Binomial logit regression results for female labour force participation in Cameroon

Variables	Pooled sample	Urban Sample	Rural sample
Age (years)			
15-19	Reference category		
20-24	0.127***	0.196***	0.095***
	(0.016)	(0.024)	(0.018)
25-29	0.201***	0.306***	0.146***
	(0.015)	(0.022)	(0.018)
30-34	0.268***	0.412***	0.182***
	(0.016)	(0.023)	(0.019)
35-39	0.292***	0.461***	0.188***
	(0.016)	(0.024)	(0.020)
40-44	0.291***	0.435***	0.209***
	(0.017)	(0.026)	(0.019)
45-49	0.316***	0.477***	0.214***
	(0.017)	(0.026)	(0.021)
Marital Status			
Single / not Cohabitating	Reference category		
Monogamous Union	0.023**	-0.013	0.058***
	(0.009)	(0.013)	(0.013)
Polygamous union	0.055***	-0.000	0.084***
	(0.011)	(0.017)	(0.015)
Education			
No education	Reference category		
Primary	0.054***	0.114***	0.058***
	(0.013)	(0.018)	(0.015)
Secondary	-0.023	0.075***	-0.021
	(0.015)	(0.019)	(0.021)
Higher	-0.038	0.047	-0.084
	(0.027)	(0.030)	(0.102)
Household head	0.084***	0.105***	0.070***
	(0.010)	(0.014)	(0.015)
Number of children in the household ages 5 and under	-0.005*	-0.011**	-0.002
	(0.003)	(0.005)	(0.003)
Currently pregnant	-0.029***	-0.055***	-0.019*
	(0.010)	(0.017)	(0.011)
Regions			
Adamawa	Reference category		
Centre	0.122***	0.083***	0.147***
	(0.024)	(0.026)	(0.041)

East	0.184***	0.132***	0.187***
	(0.027)	(0.029)	(0.042)
Far North	0.142***	0.069	0.143***
	(0.031)	(0.043)	(0.044)
Littoral	0.095***	0.091***	0.064
	(0.024)	(0.026)	(0.050)
North	0.207***	0.129***	0.220***
	(0.029)	(0.044)	(0.041)
North West	0.339***	0.307***	0.328***
	(0.025)	(0.041)	(0.038)
West	0.233***	0.218***	0.217***
	(0.025)	(0.030)	(0.040)
South	0.267***	0.194***	0.271***
	(0.025)	(0.039)	(0.038)
South West	0.306***	0.266***	0.296***
	(0.024)	(0.033)	(0.037)
Survey year			
2011	Reference category		
2004	-0.036**	-0.090***	0.029
	(0.015)	(0.016)	(0.025)
1998	0.124***	0.008	0.161***
	(0.015)	(0.018)	(0.021)
1991	0.004	-0.053*	0.054*
	(0.020)	(0.028)	(0.028)
Observations	23501	10669	12832

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 shows that a woman´s age is statistically significant at determining her participation in the labour market. In both rural and urban areas, as expected, women older than 19 are more likely to participate in the labour market than are women less than 19. This is probably due to the fact that women in this age group are most likely in full time education. In addition, the likelihood of employment increases with age.

Marital status is only statistically significant at predicting FLFP for the rural sample. Married/cohabitating women are more likely to work than single women, and women in polygamous union are more likely to participate in the labour force than those in monogamous unions. Although statistically insignificant, married/cohabitating women in urban areas are less likely to participate in the labour market than single women. Again as stated earlier, this might be due to the fact that unlike in the urban areas, partners' of women in rural areas do not earn enough to sustain their families' livelihoods, and as a result, the women have to work out of necessity.

Education also influences FLFP. In both urban and rural areas, women with a primary education are more likely to participate in the labour market than those with no education. Secondary education is statistically significant only in urban areas. Contrary to what was expected, the probability of FLFP decreases with an increase in the level of educational attainment.[41] . Higher education attainment is not statistically significant at prediction FLFP in both rural and urban Cameroon.

As expected, the result also shows that FLFP declines with the number of children in the household who are 5 or under, though only statistically significant in the urban areas. Being pregnant is also negatively related to FLFP. Women living in the Adamawa region are less likely to participate in the labour force market than those women living in the other regions of Cameroon. The highest probabilities of FLFP are found amongst women living in the North West and South West province. As expected women who were head of households are more likely to participate in the labour market. In urban Cameroon, women were less likely to work in 1991 than in 2004, and in 2004 than in 2011. On the other hand in rural Cameroon, more women worked in 1991 and in 1998, than in 2011. This is in accordance with the U-shaped hypothesis.

Hypothesis 1: Variables like age, marital status, education, the presence of small children in the household, pregnancy, region of residency, being a household head influence FLFP in urban Cameroon.

Result 1: Age, education at primary and secondary level, the presence of small children in the household, pregnancy, region of residency and being a household head were statistically significant at predicting FLFP in urban Cameroon.

Hypothesis 2: Variables like age, marital status, education, the presence of small children in the household, pregnancy, region of residency, being a household head and influence FLFP in rural Cameroon.

Result 2: Age, education at the primary level, the presence of small children in the household, pregnancy, region of residency and being a household head were statistically significant at predicting FLFP in rural Cameroon.

[41] Fika and Sokeng (2016) obtained the same result.

6.3. Decomposition Analysis

The decomposition analysis results are reported in table 4 and 5. Overall, differences in characteristics account for 36% of the rural/urban area differential in the prevalence of FLFP, whereas 64% of the variation is unexplained (coefficient effect). Both the characteristic and the coefficient effects are statistically significant (see table 4). Table 5 reports the detailed decomposition results. Of the explained part, a good amount can be accounted for by differences in education, specifically primary education. Shifting the rural women´s distribution on primary education attainment to that of urban women levels will decrease the gap by approximately 7%.[42] This is in accordance with the result of the logit regression analysis (see table 3), that revealed that of all the education levels, women with a primary education were the most likely to work. When it comes to the unexplained part, being single accounts for a good portion of the differences in FLFP. The estimate on the variable single indicates that if rural women were "penalized" for being single to the same extent as urban women, the rural/urban gap is expected to increase by 15%.[43]

Table 4

Overall results of the decomposition analysis for the FLFP differential in urban and rural areas

	%	Standard error
Differences in characteristics	35.536***	0.0070
Differences in coefficient	64.464***	0.0092

*** p<0.01, ** p<0.05, * p<0.1

[42]A positive characteristic estimate indicates the expected reduction in the rural/urban gap in FLFP if women in rural areas had the same characteristics as urban women (see Powers et al., 2011).

[43]A negative coefficient estimate indicates the expected increases in the rural/urban gap in FLFP if women in rural areas had the same return to risk as women in urban areas (see Powers et al., 2011)

Table 5

Detailed results of the decomposition analysis for the FLFP differential in urban and rural areas

Variable	Description	Differences due to Characteristics	Difference due to coefficients
Age(years)[a]	15-19	-2.9815***	7.7369***
		(0.0004)	(0.0022)
	20-24	-0.3459***	13.784***
		(0.0001)	(0.0057)
	25-29	0.9358***	10.481**
		(0.0003)	(0.0063)
	30-34	0.3092**	2.6742
		(0.0002)	(0.0052)
	35-39	0.3025*	-2.1347
		(0.0002)	(0.0046)
	40-44	-0.0258	2.8117
		(0.0001)	(0.0035)
Education[b]	No Education	14.355	14.358
		(0.0234)	(0.0161)
	Primary	6.8968*	23.174
		(0.0061)	(0.0344)
	Secondary	-11.648	11.506
		(0.0256)	(0.0431)
Marital Status[c]	Single/ not cohabitating	5.6295***	-15.159***
		(0.0014)	(0.0050)
	Monogamous Union	1.1851***	-8.8759
		(0.0006)	(0.0103)
Head of household	1 if the woman is the head of her household	-5.2487***	-0.8410
		(0.0017)	(0.0045)
Small Children	Number of children in the household ages 5 and under	-0.7985	7.7052
		(0.0014)	(0.0071)
Pregnancy Status	1 if the woman is pregnant	-0.4829*	1.8502
		(0.0004)	(0.0019)
	Observations	23501	23501

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

a = reference category is 45 -49

b = reference category is higher education

c = reference category is polygamous union

7. Educational attainment and employability

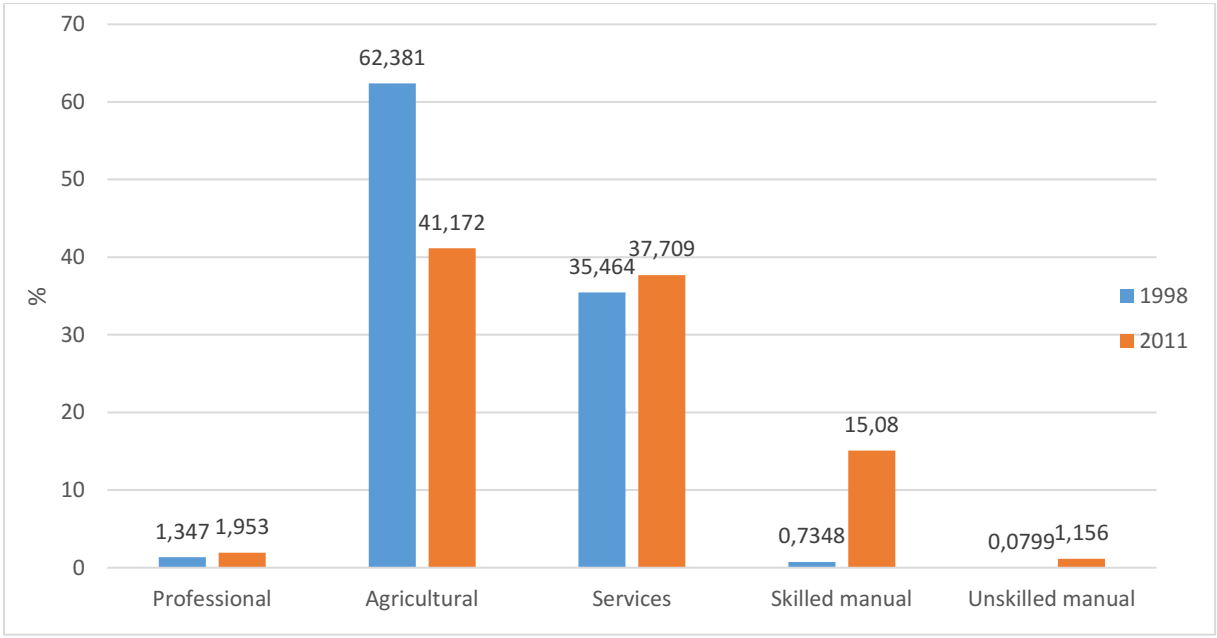
As stated above in section 6.2, contrary to what was expected, my result show that as a woman´s education increases the probability of her participating in the labour market decreases.[44] In this section I suggest possible explanations for the negative influence of higher education on FLFP. I must first state that this result has nothing to do with outliers or influential points.

Since employment is not only based on the supply side, but also on the demand side, if there is discriminatory bias against women in employment, this will negatively affect their probability of being employed. Due to societal norms women are often seen as homemakers and as such their human capital values are undermined. Figures 2 and 3 shows women and men´s employment by sector. In 1998, 62% of the female labour force were in agriculture. That number dropped to 41% in 2011. However, for men, it was 51% in 1998 and 37% in 2011. Even though the representation of women in agriculture experience a significant drop between 1998 and 2011, women were still represented in agriculture than men. Also figure 2 and 3 show that the percentage of men in the professional, technical and managerial sector exceeds that of women in both years.

Figure 4 and 5 shows the shares of women and men, respectively, in the professional, technical and managerial sector by educational attainment. These figures show that the percentage of men with a secondary education in this sector was greater than the percentage of women with a higher education. This shows that even with a higher level of education women were less likely to be employed in high skilled jobs than men with a lower level of education. So one could hypothesize that inverse relationship between education and employment is due to the fact that women with higher education are simply denied access to jobs that they are looking for (that is high skilled jobs).

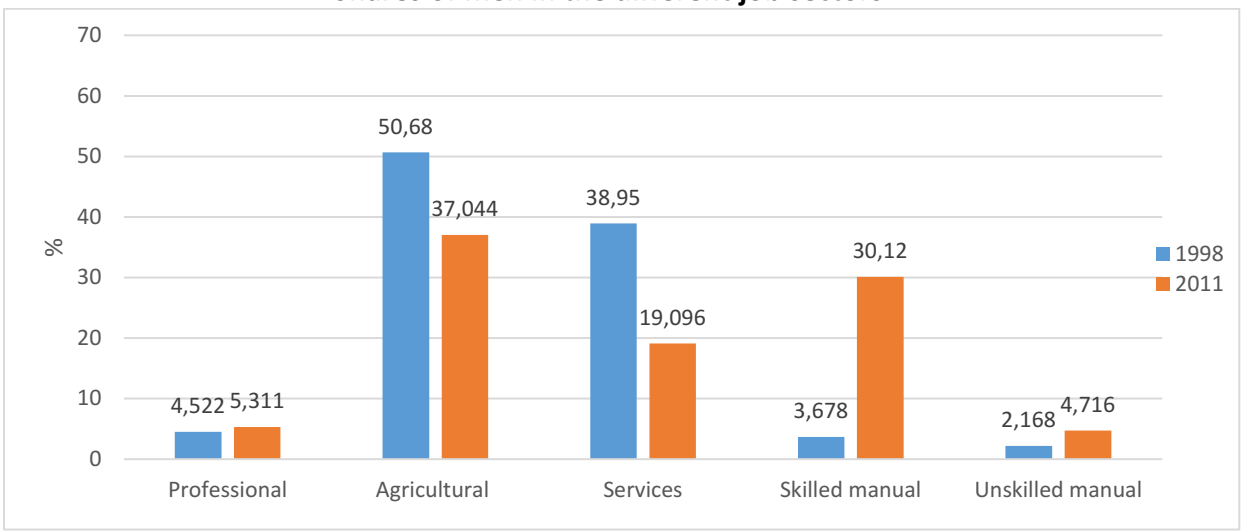
[44] For the overall and rural sample, secondary and higher education were statistically insignificant. For the urban sample higher education was statistically insignificant.

Figure 2
Shares of women in the different job sectors



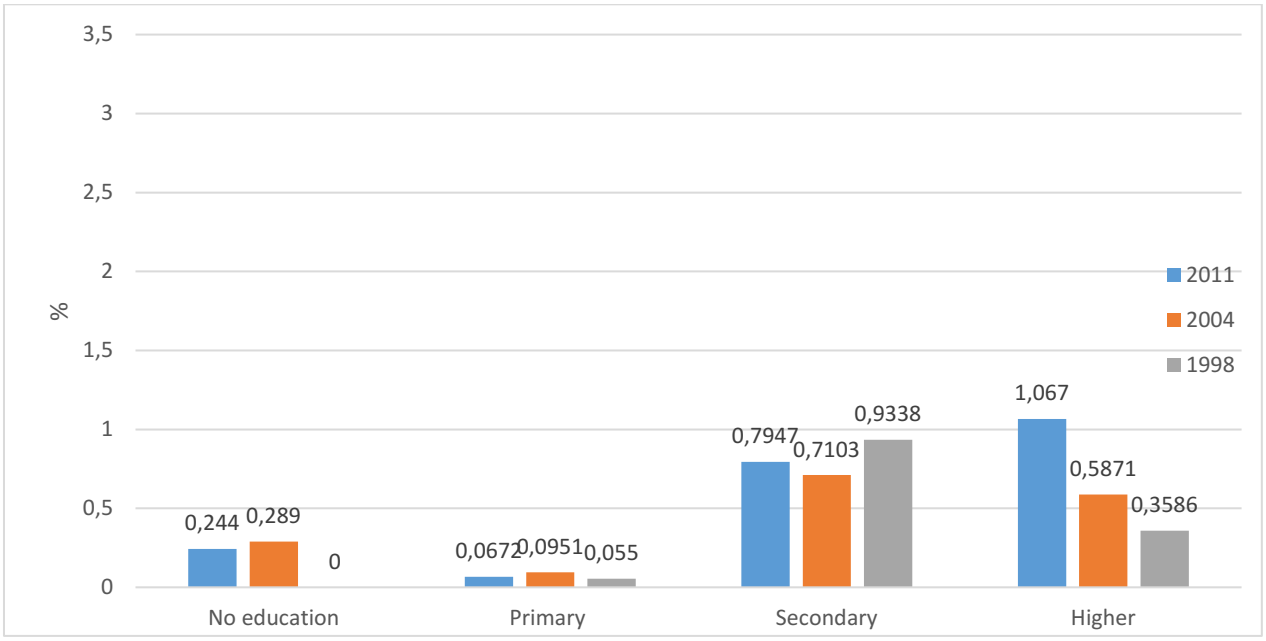
Source: Own calculation based on Demographic and Health Surveys (DHS)
Note: Agricultural includes fisherman, foresters and hunters. Following Mehra and Gammage, (1999) the service sector here includes clerical, sales and services.

Figure 3
Shares of men in the different job sectors



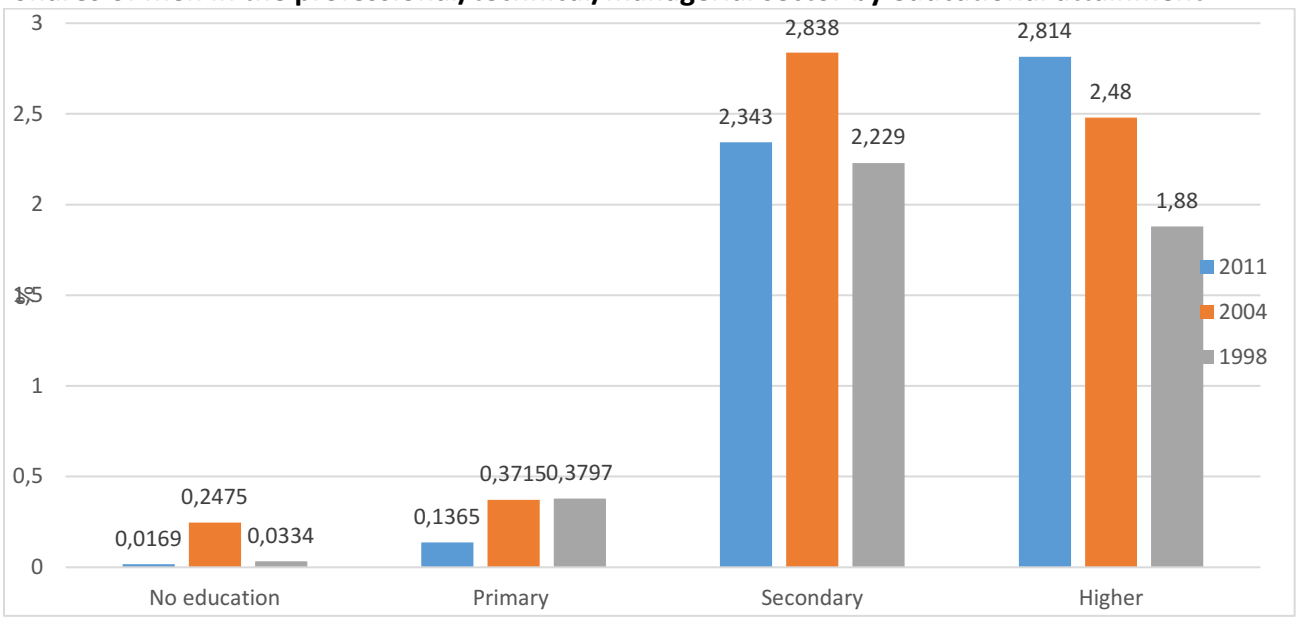
Source: Own calculation based on Demographic and Health Surveys (DHS)
Note: Agricultural includes fisherman, foresters and hunters. Following Mehra and Gammage, (1999) the service sector here includes clerical, sales and services.

Figure 4
Shares of women in the professional/technical/managerial sector by educational attainment



Source: Own calculation based on Demographic and Health Surveys (DHS)

Figure 5
Shares of men in the professional/technical/managerial sector by educational attainment



Source: Own calculation based on Demographic and Health Surveys (DHS)

A further argument could be made that women with higher education tend to marry successful men and as a result, there is no need for them to work.

8. Trends in Cameroon Labour Force Participation, 1998 to 2011

In this section, I will give a brief overview of the trends in female and male labour force participation in Cameroon between 1998 and 2011 using the DHS data. In this section, an individual is considered employed if he or she worked in the 12 months prior to the day of data collection. The decision to use this variable instead of the one used for the binomial logit regression and decomposition analysis is due to the fact that I would like to look at variables like types of earning which is a sub-question of the variable *worked in the 12 months*. In addition, the variable *worked in the last 12 months* is not available for the 1991 data, which forces me to exclude the 1991 data set from my sample. Table 6 shows the percentage of female and male workers in urban and rural Cameroon. In 1998 both the female and the male labour force was made up of a significantly higher rural labour force, 74% and 67%, respectively. In 2011, that number dropped to 55% and 47%, respectively. Between 1998 and 2011, urban labour participation increased, while rural participation decrease. A possible explanation for this trend is the high level of rural to urban migration.

Table 6
Labour force by geographical location

	Female			Male		
	1998	2004	2011	1998	2004	2011
Urban	26.17	43.36	45.49	32.63	54,18	52,91
Rural	73.83	56.64	54.51	67.37	45,82	47,09
Observations	2998	5526	8521	2343	4741	5515

Source: Own calculation based on Demographic and Health Surveys (DHS)

Table 7 shows the percentage of male and female workers of different age groups for the years 1998, 2004 and 2011. Between 1998 and 2011, the labour supply for both men and women declined for the age group 20-24. This decline may be explained by an increase in higher education attendance. While men experienced the largest increase in participation in the age group 15-19, women experience the largest participation decrease in this age group. Unlike men, the biggest participation increased for women occurred in the age group 45-49. So the slight increase in female labour force participation between 1998 and 2011 is largely due to the increase in participation of 45-49 year olds and the decrease in participation of 15-19 year olds.

Table 7
Percentage of employed by age group

	Female			Male		
	1998	2004	2011	1998	2004	2011
15-19	6.525	5.568	4.547	12.47	10.31	18,3
20-24	17.81	18.53	15.58	21.07	18.87	17,63
25-29	20.8	20.05	21.09	18.09	20.32	18,27
30-34	17.92	17.9	17.82	13.98	17.02	14,61
35-39	15.29	15.5	16.5	14.23	12.97	12,5
40-44	12.36	11.89	12.44	11.76	11.03	10,44
45-49	9.289	10.57	12.03	8.402	9.477	8,187
Observations	2998	5526	8521	2343	4741	5515

Source: Own calculation based on Demographic and Health Surveys (DHS)

Women of all age groups had a lower labour force participation in the urban areas than in the rural areas. Between 1998 and 2011 the female urban participation increased for all age groups, whereas the rural participation decreased. For all three years and for both the urban and rural areas, female participation peaks at ages 25-29 and then starts declining. In Cameroon, this age bracket in a women's life is mostly associated with marriage and child bearing. So an explanation for this decline in participation after 29 could be that women do not return to the labour force after child bearing. The male labour force also experiences a decline after 29 (Appendix B). The male urban labour force participation for all age groups increased between 1998 and 2011. On the other hand, the male rural labour force experienced a decrease for all age groups except 15-19 year olds.

Table 8 shows that for all three years, the highest percentage of women in the labour force were those with primary education as their highest level of education. The percentage of female workers with a higher education increased by 2.7 percentage points between 2004 and 2011, whereas that of males increased by 4.3. For men, those with primary education represented the highest share of workers in 1998 and 2004. In 2011 men with secondary education were the most represented in the male labour force. Both the male and female labour participation reaches its lowest for those with higher education. This is not surprising since, agriculture, where education is not a requirement for employment, is the main feature of Cameroon`s labour market. As noted the increase in participation for those with higher education attainment between 1998 and 2011 is proof of the slight shift from agriculture to other sectors like services. It would be interesting to see how the this trends has continued since 2011. I could not look at that in this study, due to lack of data.

Table 8
Labor force by educational attainment

	Female			Male		
	1998	2004	2011	1998	2004	2011
No education	30.54	28.06	23.89	15.43	13.02	9.07
Primary	43.82	43.75	41.8	43.96	41.8	35,12
Secondary	24.82	26.91	30.75	36.56	39.56	47.46
Higher	0.8218	1.281	3.55	4.051	5.623	8.348
Observations	2998	5526	8521	2343	4741	5515

Source: Own calculation based on Demographic and Health Surveys (DHS)

For both female and male in urban areas, those with secondary school education had the highest percentage of those in the labour force. In the rural areas it was those with primary education. As stated earlier, jobs in rural areas are usually in agriculture and does not require high level of education. The increase in representation of those with secondary education attainment between 1998 and 2011, is evident of the existence of jobs that require medium skilled. Higher education still remained underrepresented in both the female and male labour force in 2011(see Appendix C).

Table 9 below shows the sector shares in labour force participation for men and women for year 1998, 2004 and 2011. The professional, technical and managerial sector experienced an increase during this time period for both men and women.

Table 9
Percentage of employed by job sector

	Female			Male		
	1998	2004	2011	1998	2004	2011
Professional/technical/Managerial	1.347	1.421	1.953	4.522	5.986	5.311
Clerical	5.24	1.758	1.268	15.06	3.9	1.966
Sales	25.79	0.6256	33.25	12.28	0.6871	14.34
Agricultural (self employed)	59.29	36.99	40.12	39.54	27.62	33.6
Agricultural (employee)	3.091	17.31	1.052	11.14	14.16	3.444
Household and domestic	n/a	0.2075	2.934	n/a	0.4525	3.666
Services	4.434	3.304	3.191	11.61	12.43	2.79
Skilled manual	0.7348	4.884	15.08	3.678	11.99	30.12
Unskilled manual	0.0799	33.51	1.156	2.168	22.77	4.716

Source: Own calculation based on Demographic and Health Surveys (DHS)
Note: Agricultural categories include fisherman, foresters and hunters. For 2011, 0.05% of males stated their occupation as others.

Table 10 shows the female labour force by types of employment. In 1998 and 2011, the share of self-employment constituted the largest share amongst all categories. Table 10 shows that in 2011, 6.9% of working men and 9.8% of working women in my sample were employed in

non-wage employment. Out of the paid workers 61.5% and 74.61% of women and men respectively, received only cash as their earnings. The percentage of unpaid women workers increased by 1.5 percentage points between 2004 and 2011. Unfortunately, there isn't enough data available to further investigate these trends.

Table 10
Labour force by types of earning

	Female		Male
	2004	2011	2011
Unpaid	8.328	9.842	6,51
Cash	45	61.2	74,82
Cash and kind	30.1	22.85	17,12
In Kind	16.57	6.108	1,552
Observations	5526	8521	5515

Source: Own calculation based on Demographic and Health Surveys (DHS)

9. Conclusions and recommendations

Female labour force participation promotes various types of gender equality in society and in the home, which in turn boosts economic development (Goldin, 1995), so knowing the factors that determine FLFP is of great importance. This study investigated the determinants of FLFP in urban and rural Cameroon. The factors generally found as predictors for FLFP are significant in predicting FLFP in Cameroon. However, the impact of education does not act as expected. The likelihood of a woman participating in the labour market decreases with educational attainment. I hypothesized that this inverse relationship is mostly due to discrimination in employment. For example, women with a higher education had a lower share in higher skilled jobs than men with a secondary school education. To improve women´s employment I recommend the following policy changes. Firstly more detailed data collection is needed in order to better understand the female labour force in Cameroon. Secondly, firms should be encouraged to ensure equal access to all sectors for both men and women.

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Appendix A

```
/* keep only usual residence. (delete visitors)*/
replace v135 =. if v135 == 9
keep if v135 == 1
/* cleaning the variables and creating dummy variables*/

* Dealing with v714 (whether the correspondent is currently working) variable:
replace v714 =. if v714 == 9

* Dealing with v150 (whether respondent is head of household) variable:
replace v150 =. if v150 ==99
replace v150 =. if v150 ==98
gen headofhousehold = 0
replace headofhousehold =1 if v150==1


* v013 (age in 5 year group) variable:
gen age1 = 0
replace age1 = 1 if v013 ==1 // for descriptive statistics
gen age2 = 0
replace age2 = 1 if v013 ==2
gen age3 = 0
replace age3 = 1 if v013 ==3
gen age4 = 0
replace age4 = 1 if v013 ==4
gen age5 = 0
replace age5 = 1 if v013 ==5
gen age6 = 0
replace age6 = 1 if v013 ==6
gen age7 = 0
replace age7 = 1 if v013 ==7

* v013 (age in 5 year group) variable:
gen age = 0 //
replace age = 1 if v013 ==1
replace age = 2 if v013 ==2
replace age = 3 if v013 ==3
replace age = 4 if v013 ==4
replace age = 5 if v013 ==5
replace age = 6 if v013 ==6
replace age = 7 if v013 ==7

*v137 ( Number of children residing in household  and aged 5 and under):
replace v137 =. if v137 ==19
```

```
* Dealing with v106 (highest education level) variable for descriptive statistics:
gen noeduc = 0
replace noeduc = 1 if v106 ==0
gen primaryeduc = 0
replace primaryeduc = 1 if v106 ==1
gen secondaryeduc = 0
replace secondaryeduc = 1 if v106 ==2
gen highereduc = 0
replace highereduc = 1 if v106 ==3

/* for logistic regression*/
gen educ = 0
replace educ = 1 if v106 ==0
replace educ = 2 if v106 ==1
replace educ = 3 if v106 ==2
replace educ = 4 if v106 ==3

* Dealing with v502 (marital status) variable for descriptive statistics:
gen married = 0
replace married = 1 if v502 == 1

* Dealing with v505 (number of other wives for married people):/*for those who are not married to get 0 instead of missing*/
replace v505 = 0 if married == 0
replace v505 =. if v505 == 98
replace v505 =. if v505 == 99

gen polygamy = 0
replace polygamy = 1 if v505 > 0

gen poly = 0
replace poly = 1 if married == 0
replace poly = 2 if married == 1 & v505 ==0
replace poly = 3 if polygamy == 1

/* descriptive statistics  1 is unmarried, 2 is monogamous union 3 is polygamous union*/
gen poly1 = 0
replace poly1 = 1 if poly ==1
gen poly2 = 0
replace poly2 = 1 if poly ==2
gen poly3 = 0
replace poly3 = 1 if poly ==3

* dealing with v025 ( living in urban area):
gen urban =0
replace urban = 1 if v025 ==1 // 1 if living in Urban area

* dealing with v213 ( current pregnancy status1 is yes and 0 no:
```

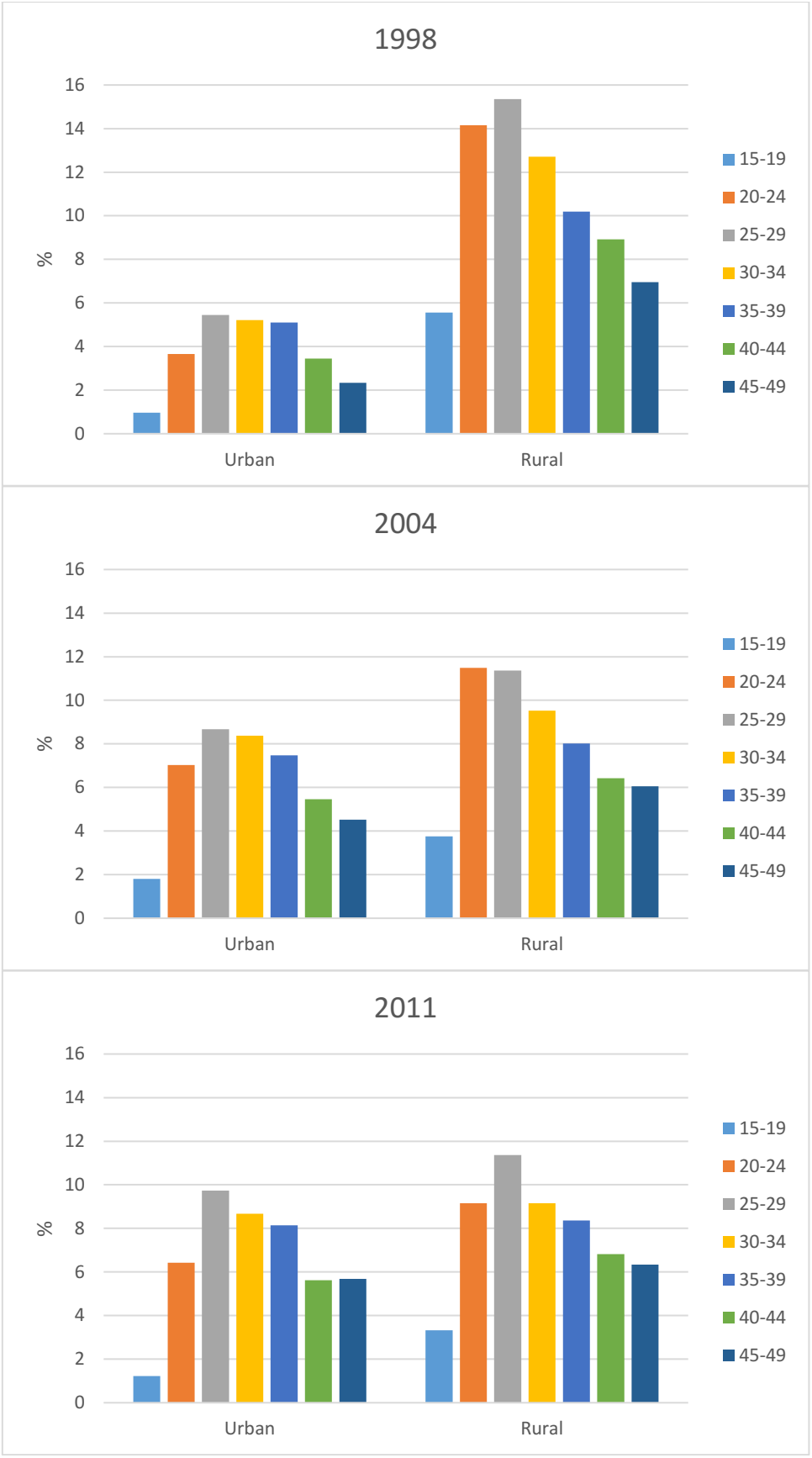
```
* dealing with v024 (Regions) for descriptive statistics:
gen Adamawa = 0
replace Adamawa = 1 if v024 ==1
gen Centre = 0
replace Centre = 1 if v024 == 2|v024 ==12
gen East = 0
replace East = 1 if v024 ==4
gen Farnorth = 0
replace Farnorth = 1 if v024 ==5
gen Littoral = 0
replace Littoral = 1 if v024 ==6| v024 ==3
gen North = 0
replace North = 1 if v024 ==7
gen Northwest = 0
replace Northwest = 1 if v024 ==8
gen West = 0
replace West = 1 if v024 ==9
gen South = 0
replace South = 1 if v024 ==10
gen Southwest = 0
replace Southwest = 1 if v024 ==11

* dealing with v024 (Regions) for logistic regression:
gen region = 0
replace region = 1 if v024 ==1
replace region = 2 if v024 == 2|v024 ==12
replace region = 3 if v024 ==4
replace region = 4 if v024 ==5
replace region = 5 if v024 ==6| v024 ==3
replace region = 6 if v024 ==7
replace region = 7 if v024 ==8
replace region = 8 if v024 ==9
replace region = 9 if v024 ==10
replace region = 10 if v024 ==11


/* to sample each mom only once*/
egen byte mom_once = tag (caseid)
keep if mom_once == 1

/* 1991 data for  9 observations with missing values. drop observations with missing value*/
missings report
drop if missing(v150)
drop if missing(v505)
drop if missing(v506)
gen survey = 0
replace survey = 4
```

```
/* 1998 data for  22 observations with missing values. drop observations with missing value*/drop if missing(v714)
missings report
drop if missing(v714)
drop if missing(v505)
drop if missing(v506)
gen survey = 0
replace survey = 3

/* 2004 data for 33 observations with missing values. drop observations with missing value*/
missings report
drop if missing(v714)
drop if missing(v505)
drop if missing(v506)
gen survey = 0
replace survey = 2

/* 2011 data 467 drop observations with missing value*/
drop if missing(v137)
drop if missing(v150)
drop if missing(v714)
drop if missing(v505)
drop if missing(v506)
missings report  //missing value reports
gen survey = 0
replace survey = 1

 /* 1= 2011 ,2 = 2004, 3 = 1998, 4= 1991, */

append  using  "\\CL02-SFH-SERVER\SFH\sf\home\agborndip\Konfig32\Desktop\Phd\Female labour supply\Working paper Determinants of FLFP\workingdata2004uptillmissingreport.dta"

append  using  "\\CL02-SFH-SERVER\SFH\sf\home\agborndip\Konfig32\Desktop\Phd\Female labour supply\Working paper Determinants of FLFP\workingdata1998uptillmissingreport.dta"

append  using  "\\CL02-SFH-SERVER\SFH\sf\home\agborndip\Konfig32\Desktop\Phd\Female labour supply\Working paper Determinants of FLFP\workingdata1991uptillmissingreport.dta"

/* specifying the survey design*/
gen weight = v005/1000000
egen clusters=group(survey v021), label
egen strata = group(survey v024 v025), label
svyset clusters [pweight=weight], strata(strata) singleunit(centered)
```

```
/*descriptive statistics and creating tables*/
svy: mean v714 age1 age2 age3 age4 age5 age6 age7 poly1 poly2 poly3 noeduc primaryeduc secondaryeduc highereduc headofhousehold v137 v213 Adamawa Centre East Farnorth Littoral North Northwest West South Southwest survey
outreg2 using E:\olsregression.doc, replace dec (2) pdec(4)

svy, subpop( if urban==1): mean v714 age1 age2 age3 age4 age5 age6 age7 poly1 poly2 poly3 noeduc primaryeduc secondaryeduc highereduc headofhousehold v137 v213 Adamawa Centre East Farnorth Littoral North Northwest West South Southwest survey
outreg2 using E:\olsregression.doc, append dec (2) pdec(4)

svy, subpop(if urban ==0): mean v714 age1 age2 age3 age4 age5 age6 age7 poly1 poly2 poly3 noeduc primaryeduc secondaryeduc highereduc headofhousehold v137 v213 Adamawa Centre East Farnorth Littoral North Northwest West South Southwest survey
outreg2 using E:\olsregression.doc, append dec (2) pdec(4)

/*Logit regression to study relationship between FLFP vpolygamy are those in polygamy marriages, v213 is pregnancy status v137 is number of children in household aged 5 and under*/

svy: logit v714 i.age i.poly i.educ i.headofhousehold v137 v213 i.region i.survey
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)

svy, subpop ( if urban ==1): logit v714 i.age i.poly i.educ i.headofhousehold v137 v213 i.region i.survey
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)

svy, subpop ( if urban ==0): logit v714 i.age i.poly i.educ i.headofhousehold v137 v213 i.region i.survey
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)

// *decomposition analysis*//
gen area = 0
replace area = 1 if urban == 0

mvdcmp area : logit v714 age1 age2 age3 age4 age5 age6 age7 noeduc primaryeduc secondaryeduc highereduc poly1 poly2 poly3 headofhousehold v137 v213 Adamawa Centre East Farnorth Littoral North Northwest West South Southwest survey1 survey2 survey3 survey4 [pweight=weight]
outreg2 using E:\olsregression.doc, replace dec (4) pdec(4)

mvdcmp area : logit v714 age1 age2 age3 age4 age5 age6 age7 noeduc primaryeduc secondaryeduc highereduc poly1 poly2 poly3 headofhousehold v137 v213[pweight=weight]
outreg2 using E:\olsregression.doc, replace dec (4) pdec(4)
```

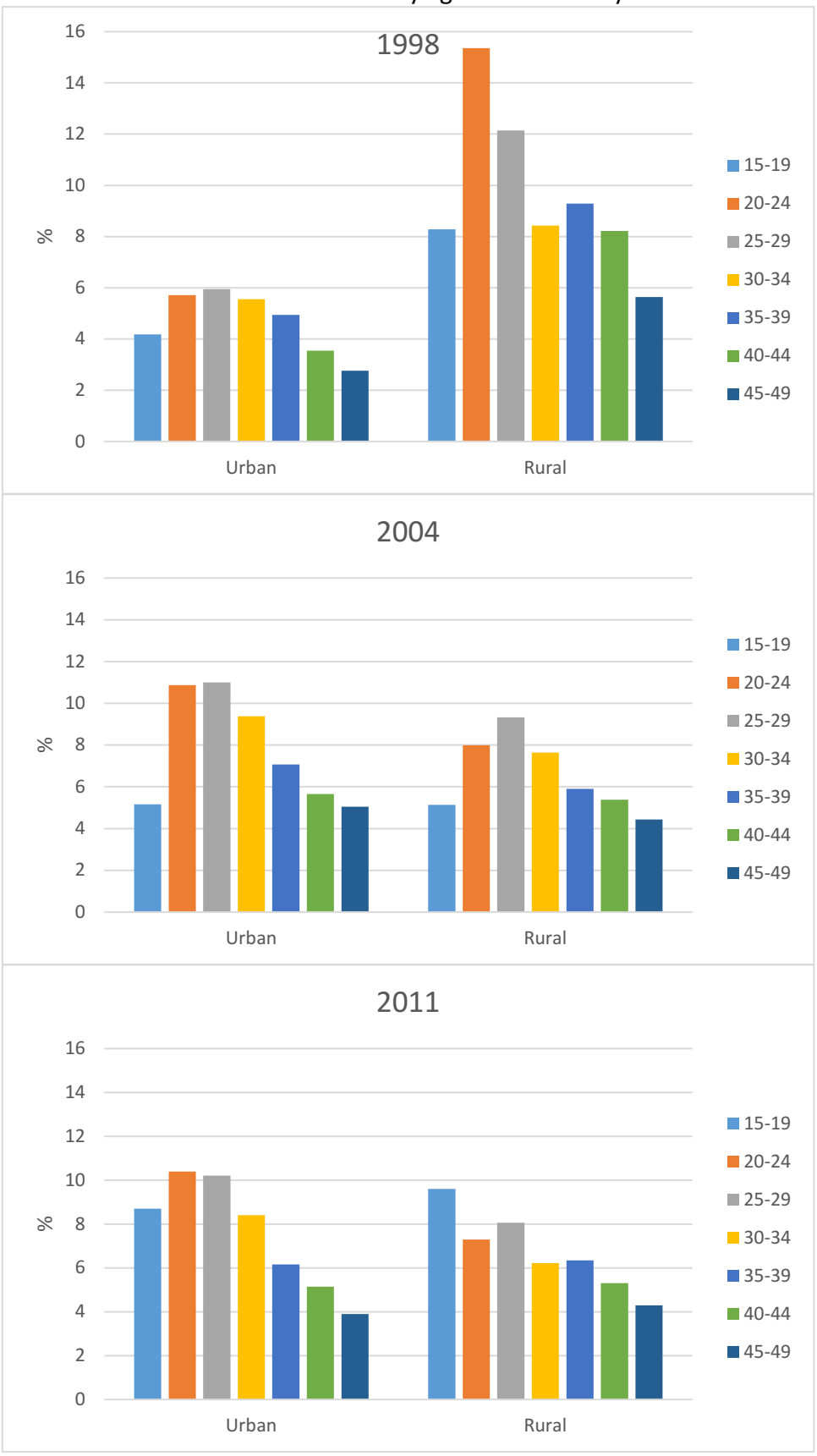
Appendix B

Female labour force by age and residency



Source: Own calculation based Demographic and Health Surveys (DHS)

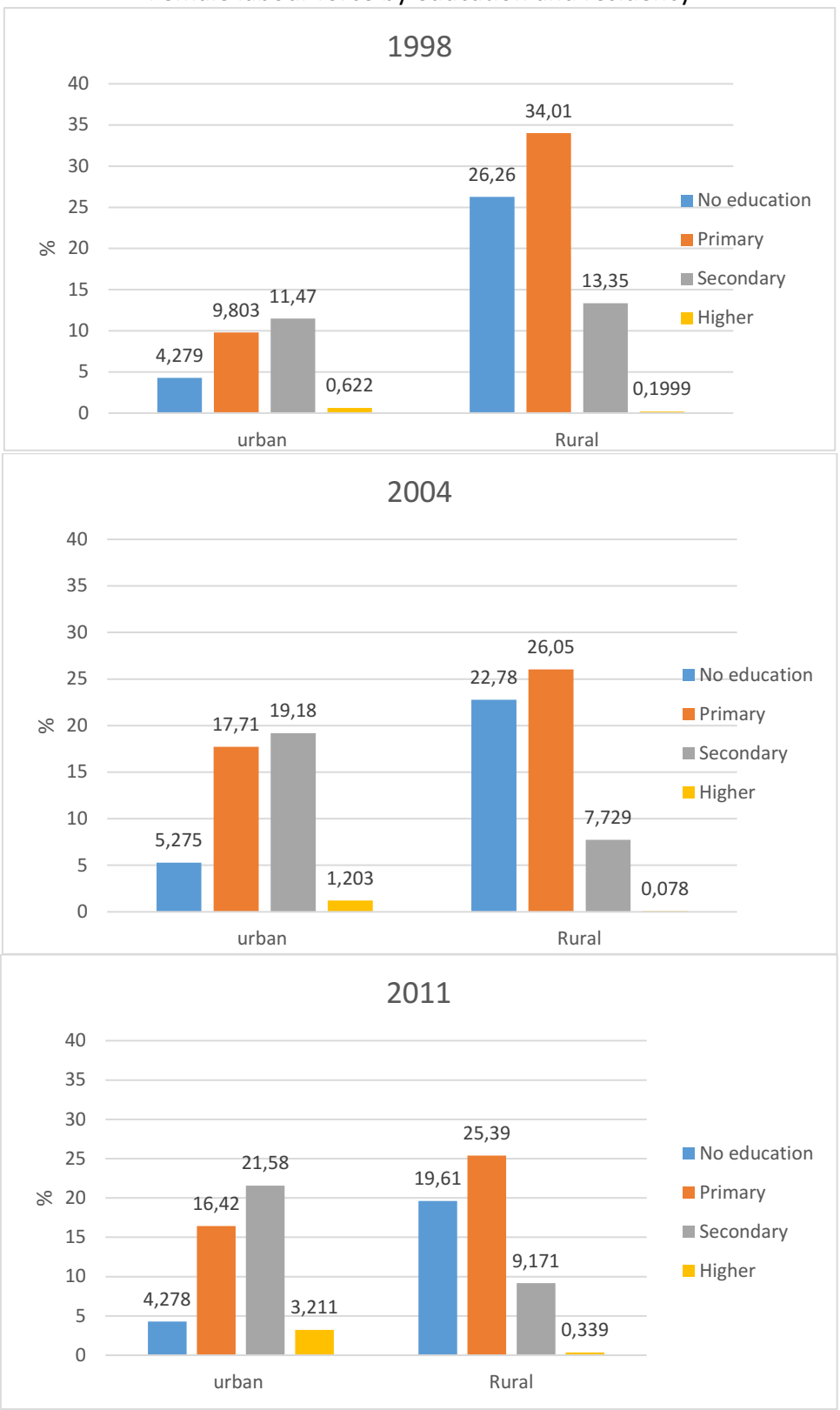
Male labour force by age and residency



Source: Own calculation based Demographic and Health Surveys (DHS)

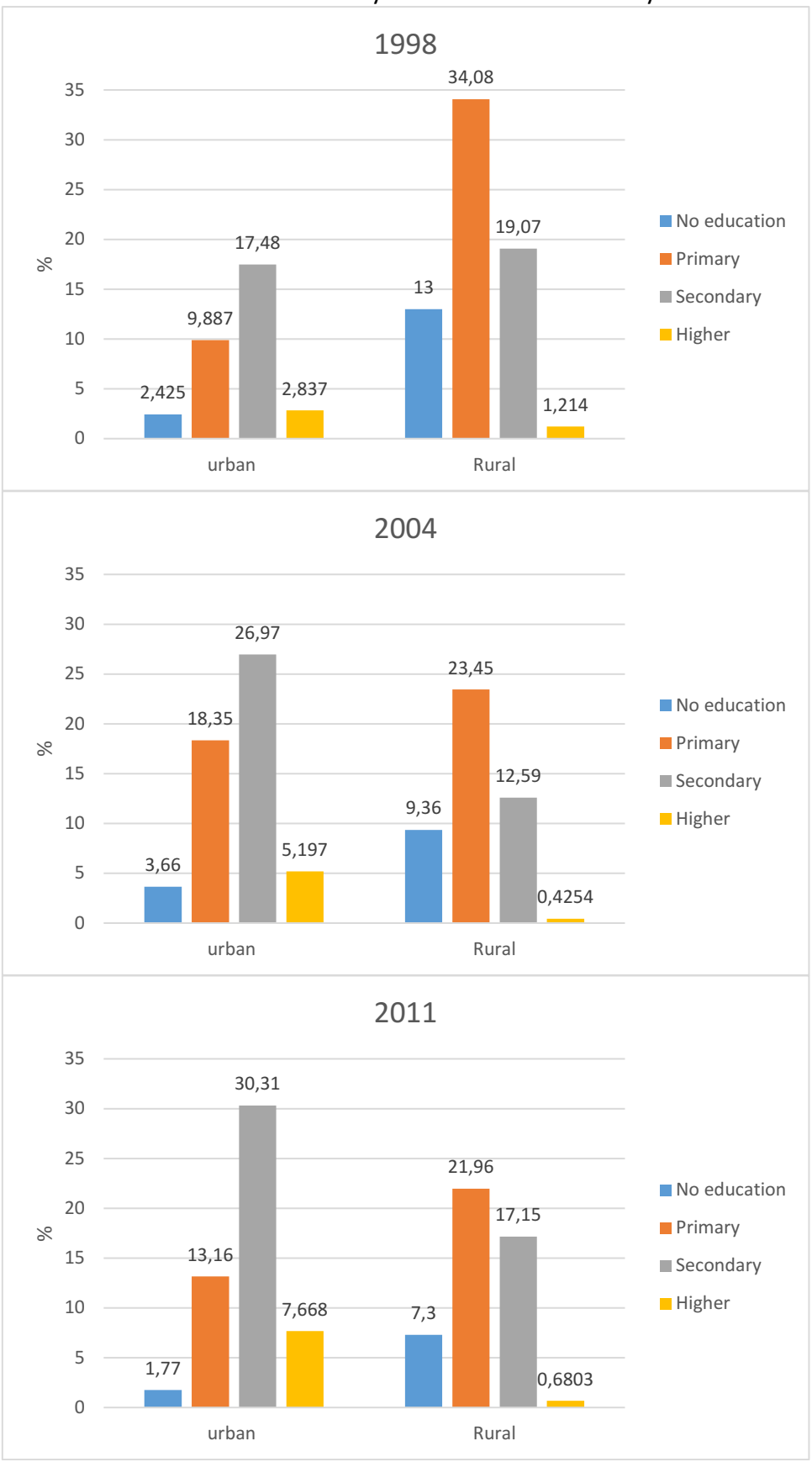
Appendix C

Female labour force by education and residency



Source: Own calculation based Demographic and Health Surveys (DHS)

Male labour force by education and residency



Source: Own calculation based Demographic and Health Surveys (DHS)

PAPER 4:

Is Sibling Gender Composition a Good Instrumental Variable for Fertility in Cameroon?

Abstract

In this study, I investigate the effectiveness of sibling gender composition as an instrument for fertility in Cameroon. Determining the effect of fertility on female labour force participation is complicated because the same factors that influence fertility may also influence female labour force participation. To solve this problem, researchers have used amongst other instruments, the gender of the first two children as a source of exogenous variation in family size. Several studies have found sibling gender composition to be a strong instrument for fertility. The result of this study shows that it is a poor instrument for fertility in Cameroon.

1. Introduction

In recent years, female labour force participation, FLFP thereafter, has increased remarkably. Corresponding to an increase in FLFP, there has also been a drop in fertility rates. The causal link between fertility (number of children born) and FLFP has been of great interest to social scientists. Demographers have studied FLFP as a determinant of fertility, whereas labour economists mainly study fertility as a key determinant of FLFP (Cramer 1979). According to theories of household production, there is an inverse relationship between fertility and FLFP (Becker, 1960; Willis 1973). The hypothesis is that child rearing is time demanding and acts as opportunity costs. Thus, as a woman´s wage increases, her demand for children decreases. In addition, empirical studies in developed countries generally find a negative relationship between the presence or the number of children and FLFP (Mincer, 1985; Browning, 1992). In developing countries even though empirical evidence of this relationship is present, it is less consistent (Lloyd, 1991; Bianchi, 2000).

According to O´Neill (2003), the significant difference in FLFP between mothers and non-mothers is one of the main reasons for the overall gender difference in wages. In addition, Klasen and Lamanna (2009) find that gender gaps in employment reduces economic growth more than gender gaps in education does. Hence, understanding the effect of the number of children born (fertility) on FLFP is important for dealing with the gender wage gap issue. Also understanding the relationship between fertility and FLFP is important for predicting the changes in size and composition of the labour force.

The main problem with investigating the causal relationship between fertility and FLFP is disentangling the link between fertility and FLFP. Fertility may affect FLFP, but FLFP may also affect fertility (reverse causality), and other observable and unobservable characteristics may affect both fertility and FLFP. Fertility is also likely to be correlated with the error term in an equation of FLFP and will, therefore, give biased ordinary least square (OLS) estimates. To deal with this problem of the endogeneity of the fertility decision, researchers have suggested the use of instrumental variables (Angrist and Evans, 1998; Aguero and Marks, 2008). It involves finding a variable which is correlated, negatively or positively, with fertility but not with any other unobserved factors or FLFP. Birth of twins and infertility are instruments which have been used but are difficult to use except in large data sets because they are very rare events.

In this paper, I investigate the effectiveness of an instrumental variable proposed by Angrist and Evans (1998) on Cameroon data. Angrist and Evans (1998) use the gender composition of the first two children in families with two or more children as an instrument for the effect of the birth of a third child (fertility) on FLFP in the US. They exploit the fact that parents prefer a mixed sibling-gender composition (Ben-Porath and Welch, 1976). That is, parents whose first two children are of the same gender are more likely to go on and have a third child than parents whose first two children are of opposite gender. Since the gender of a child is randomly assigned, a dummy variable for whether the gender of the second child is the same as that of the first child is a reasonable instrument for measuring the effect of an additional child (fertility) on FLFP amongst women with at least two children (Angrist and Evans, 1998 p.451).

Several other studies have used this instrument to deal with the endogeneity of fertility. Iacovou (2001) for the United Kingdom, Cruces and Galiani (2007) for Argentina and Mexico, Hirvonen (2009) for Sweden and Van der Stoep (2009) for South Africa.To the best of my knowledge, Van der Stoep (2009) is the only study of this nature performed on the African continent. For this reason, this paper will begin to fill the gap in literature by determining if this identification strategy can be used to addresses the causal effect of fertility on FLFP in Cameroon, a West African Country.

The rest of the paper is divided as follows: Section 2 focuses on the economic theory of labour supply, in section 3 I give an overview of instruments that have been used in previous research to deal with the endogeneity of the fertility decision. In section 4 I discuss the data source and summary statistics of the data. In section 5 I present the methods used in this study followed by section 6 where I present the main results. Finally, in section 7 I conclude the study with a summary.

2. Theoretical Background

An economy´s labour supply is the sum of the work choices made by each individual in the population. In the neoclassical model of labour supply decision to work involves the optimal allocation of time across work and leisure. Leisure is defined as any activity other than supplying labour to the market and provides direct satisfaction to the individual. An individual cannot pursue labour and leisure at the same time. The opportunity cost of an additional hour of leisure is the wage which could have been earned. On the other hand, the opportunity cost

of an additional hour of labour is the satisfaction that would have been derived from leisure. A person´s decision to work is based on a comparison of the market wage, which indicates how much employers are willing to pay for an hour of work, and the reservation wage, which indicates how much the worker requires to work. A person enters the labour market when the market wage is higher than the reservation wage. Hence the labour force participation rate corresponds to the proportion of individuals whose reservation wage is less than the market wage (Borjas, 1999; Cahuc et al., 2014).

One criticism of the neoclassical model of labour supply is that it does not take into consideration the different activities outside of work, instead, it considers all activities outside of work as leisure. However, leisure is not the only alternative to wage work. Household jobs like cleaning and cooking are not leisure. Another aspect the traditional theory of labour supply neglects is that decisions about labour supply are frequently made by several members of the household (Cahuc et al., 2014).

Gary Becker´s 1965 seminal paper on the theory of the allocation of time addresses these shortcomings. The main assumption of this theory is that households are both producers and consumers. According to Becker (1965), a family´s utility is not received directly from its consumption of a market good, as the traditional theory suggest. Instead, by combining goods purchased from the market and time supplied by each family member, the family produces commodities which are the family's utility (Becker, 1965). Hence family utility is a function of a vector of non-marketable, home-produced commodities for example entertainment, good health, nutrition, satisfaction from children etc. (Willis, 1973). In Becker's model time is allocated across three basic activities namely, wage work, household work and leisure and the family and not a single individual maximize utility. In multi-persons households the decision about which members does wage work or household work is determined by their efficiency in wage or household work (specialization). In most cases women are more efficient in household work than men, so women are more likely to trade off wage work for household work and a high proportion of their husbands would then trade off leisure and household work for wage work (Becker, 1985; Cahuc et al., 2014).

Economic theory states that fertility has two different effects on the family´s labour supply. Firstly, due to the specialization effect (Becker, 1985) mentioned above an increase in fertility will result in women spending more time in child care. In contrast, men are likely to spend

more time and energy in market work in response to an increase in fertility. Secondly, the home-intensity effect (Lundberg and Rose, 2002) results from the increased value of both parents´ time as inputs to child care after a child is born. This leads to both the women and the men spending more time in household work in response to the birth of a child. Both effects predict that FLFP will decrease in response to an increase in fertility. When it comes to male labour force participation, it is ambiguous. In response to fertility, male labour force participation will increase or decrease depending on which of the effects dominates the other. The greater the extent to which a father participates in child care, the more likely it is that home-intensity effect will dominate the specialization effect, leading to a decrease in the number of hours spent doing wage work after a child is born and vice versa.

3. Literature Review

A huge amount of research has been done on the effect of fertility on FLFP worldwide. A majority of these studies have documented a negative relationship between the presence of children in the household and FLFP (Browning, 1992). However, the interpretation of this relationship is complicated by the endogeneity problem that arises when using fertility as the explanatory variable in an OLS equation. Browning (1992 p. 1435) states that "… although we have a number of robust correlations, there are a few credible inferences that can be drawn from them." The number of children a woman has may affect her labour force participation, but a woman´s labour force participation may also affect the number of children she has (reverse causality). Additionally, other observable and unobservable characteristics may affect both fertility and FLFP. Hence, standard ordinary least square estimates may be biased and inconsistent. To address the endogeneity of fertility, researchers have employed instrumental variable (IV) estimation.

Angrist and Evans (1998) use the gender composition of the first two children as an exogenous instrument to estimate the effect of further child bearing on FLFP. Their strategy is based on the fact that the gender composition of children is random and that many couples prefer to have a mixed gender composition (Ben-Porath and Welch, 1976). Angrist and Evans (1998) found a significantly negative effect of having a third child on FLFP in the United States. They also showed that the instrumental variable estimates are less negative than the OLS estimates. A number of other researchers have extended Angrist and Evans´s (1998) work to other countries. Cruces and Galiani (2007) study the effect of fertility on maternal labour supply in

Argentina and Mexico. They found that in both Argentina and Mexico, child bearing leads to a reduction in FLFP. Hirvonen (2009), using Swedish data, found that having an additional child has a stronger negative impact on female earnings than on FLFP. Iacovou (2001), using UK data, found positive but not statistically significant effects of fertility on FLFP. Van der Stoep (2009) found sibling sex composition to be a weak instrument for fertility among African women in South Africa.

Another instrument for fertility used in literature is the sex of the first child. Chun and Oh (2002) investigated the impact of fertility on FLFP in Korea. Korean family prefer sons to daughters, so the number of children in a family is strongly related to their first child´s gender. Using this exogenous variation as an instrumental variable for fertility, they found that having children reduces labour force participation of Korean married women by 27.5 percent.

Studies have also used the occurrence of twins at first birth to estimate the effect of fertility on FLFP. By comparing labour participation of women who had twins at first birth and those who had a single child, Rosenzweig and Wolpin (1980) found that the transitory increase in the number of children experienced by twin mothers had no impact on FLFP. Using similar strategy, Bronars and Grogger (1994) found that having twins at first birth has large short-term effects on unmarried mothers´ labour force participation and no effects amongst married mothers. Gangadharan and Rosenbloom(1996) also used fertility due to twin births to measure the impact of an unplanned child on married women´s labour supply. They found the overall effects of an unplanned birth on labour supply to be initially small and then a significant effect in the years following the unplanned birth.

Aguero and Marks (2008) used infertility as an instrument for family size to study the effect of fertility on FLFP in six Latin America countries. They found that children do not affect the likelihood to work or the number of hours mothers work, but impacts the type of work a woman pursues.

4. Data

The data used in this study comes from the Integrated Public Use Microdata Series International (IPUMS-International). IPUMS-International is a project dedicated to collecting,

harmonizing and distributing census data from around the world.[45] I analyze the data for Cameroon for 1976, 1987 and 2005.

Using the gender of the first two children as an instrument for fertility means my sample is restricted to only mothers with two or more children. Unlike Angrist and Evans (1998) whose sample included mothers aged 21-35, my sample consist of mother between 15 and 35years old. This is because in Cameroon women start bearing children at a younger age than in the US. For example in my 1976 data 90 15year olds had two or more children. In 1987 and 2005, it was 195 and 383 respectively.

5. Econometric Methodology

5.1. Inconsistency of Ordinary Least Square Estimations

Consider the following simple regression equation:

$$FLFP = \beta_0 + \beta_1 Fertility + u_i, \quad (5.1)$$

Where β_1, the parameter of interest, represents the average effect of having an additional child on FLFP and u_i is the error term. Standard regression estimates assumes that the regressors are uncorrelated with the errors in the model. That is, the only effect of fertility on FLFP is a direct effect via the term β_1. However, women with fewer children might have unobserved characteristics in the error term of equation 5.1 which differs from women with many children. So, for example, women who are focused on the quality of children will have fewer children than those who are not (Becker& Lewis, 1973). Thus the former women will tend to participate in the labour force. So estimating equation 5.1 by ordinary least squares will give biased and inconsistent estimates of β_1.

5.2. Instrumental Variable Estimation

The endogeneity issue can be solved by finding an instrumental variable for the endogenous regressor, fertility. Following Wooldridge (2013), a valid instrumental variable, *Z*, for *X* (endogenous variable) must be (1) correlated with *X*. This is referred to as instrument relevance.

$$Cov(Z, X) \neq 0 \quad (5.2)$$

[45] See Jeffers et al. (2017) for a detail explanation of the IPUMS-International project.

(2) uncorrelated with u (the error term). This is called instrument exogeneity.

$$Cov\,(Z,u) = 0 \tag{5.3}$$

5.2.1. The Wald Estimator

The Wald estimator is the simplest instrumental variable estimator that uses a single binary instrument to estimate a model with one endogenous regressor and no covariate (Angrist & Pischke, 2009).Let Z_i denote the binary (0-1) instrument, X_i the endogenous regressor and Y_i the dependent variable. The effect of the instrumental variable on the endogenous regressor can be measured as

$$E[X_i \mid Z_i = 1] - E[X_i \mid Z_i = 0] \tag{5.4}$$

Similarly, the effect of the instrument on the dependent variable is

$$E[Y_i \mid Z_i = 1] - E[Y_i \mid Z_i = 0] \tag{5.5}$$

Taking the expectation of (5.1) for $Z_i = 1$

$$E[Y_i \mid Z_i = 1] = \beta_0 + \beta_1 E[X_i \mid Z_i = 1] + E[U_i \mid Z_i = 1] \tag{5.6}$$

And then for $Z_i = 0$

$$E[Y_i \mid Z_i = 0] = \beta_0 + \beta_1 E[X_i \mid Z_i = 0] + E[U_i \mid Z_i = 0] \tag{5.7}$$

Subtracting (5.7) from (5.6) yields the effect of the instrument on the dependent variable

$$E[Y_i \mid Z_i = 1] - E[Y_i \mid Z_i = 0] = \beta_1 \left(E[X_i \mid Z_i = 1] - E[X_i \mid Z_i = 0]\right) + E[U_i \mid Z_i = 1] - E[U_i \mid Z_i = 0] \tag{5.8}$$

Thus

$$\beta_1 = \frac{E[Y_i \mid Z_i = 1] - E[Y_i \mid Z_i = 0]}{E[X_i \mid Z_i = 1] - E[X_i \mid Z_i = 0]} \tag{5.9}$$

The instrumental variable estimate of β_1 (Wald estimator) is simply the ratio of the reduced-form relationships between Y_i and Z_i and X_i and Z_i and it is defined as

$$\beta_1 = \frac{(\overline{Y_1} - \overline{Y_0})}{(\overline{X_1} - \overline{X_0})} \tag{5.10}$$

where $\overline{Y}_1(\overline{Y}_0)$ is the mean of the dependent variable for those with $Z_i = 1$ ($Z_i = 0$). X_i is defined in the same way. The Wald estimate shows that the relationship between the dependent variable and the instrument can only be explained by the effect of the instrument on the endogenous variable (Angrist & Pischke, 2009 p. 95).The Wald estimate, $ß_1$, can be interpreted as the local average treatment effect (LATE) specific to the instrument (Imbens & Angrist, 1994).

5.2.2. Two-Stage Least Squares

As stated in the previous subsection, the Wald estimator is an instrumental variable estimator that does not involve covariates. However, controlling for exogenous covariates can yield more precise estimates by reducing variability in the dependent variable (Angrist & Pischke, 2009 p. 132). To achieve this, β_1 can also be estimated using an instrumental variable estimator called two-stage least squares (2SLS). The 2SLS estimate is calculated in two stages. In the first stage, the part of X which is uncorrelated with the error term is isolated. This is done by regressing the endogenous variable on the instrument. Since the instrumental variable is uncorrelated with the error term, the estimates of this regression are also uncorrelated with the error term. The first stage regression is

$$X = \beta_0 + \beta_1 Z + u_i, \tag{5.11}$$

Where X is the endogenous variable and Z is the instrumental variable.

In the second stage, the part of X that is uncorrelated with the error term obtained from the first stage is used to estimate the effect of a change in X on Y. The second stage regression is

$$Y = \beta_0 + \beta_1 \hat{X} + u_i, \tag{5.12}$$

Where Y is the dependent variable, $\hat{X}$ is the predicted value of *X* obtained from equation 5.11. It is worth noting that the standard errors of the 2SLS are incorrect if done in two separate steps (Angrist & Pischke, 2009). However this can be corrected by using specialized commands in statistical softwares like Stata.

Previous studies have shown that sibling gender composition satisfies the two requirements for a good instrumental variable (see Angrist and Evans, 1998; Cruces and Galiani, 2007). In this paper, I investigate whether gender composition of the first two children in families with two or more children is a good instrument to estimate the effect of fertility on FLFP in

Cameroon. To test the instrument relevance (equation 5.2) I regress the endogenous variable *X* on the instrument *Z* (the first stage regression). *X* is defined as *more than two children*. It takes the value 1 if a woman has more than two children or zero, otherwise. The instrumental variable, Z, defined as *same gender*, takes the value 1 if a woman´s first two children are of the same gender or zero, otherwise. Due to the fact that the decision to have a third child may differ if the first two children of the same gender are girls or boys I decompose the same gender instruments into two instruments, *two girls* and *two boys*.

The first stage regression linking more than two children (fertility) to gender composition are:

$$X_i = \pi_0 D_i + \phi(samegender_i) + \eta_i \tag{5.13}$$

$$X_i = \pi_0 D_i + \phi(twoboys_i) + \eta_i \tag{5.14}$$

$$X_i = \pi_0 D_i + \phi(twogirls_i) + \eta_i \tag{5.15}$$

where X_i is the endogenous fertility variable measured through having *more than two children*, D_i is a vector of demographic variables such as mother´s age, education etc., ϕ is the effect of the instrumental variable and η_i is the error term. Due to the binary nature of the dependent variable, logistic regression is used to test this assumption. In using the first stage regression model to test for instrument relevance, it is important not only to look for statistical significance but also to look at the sign and magnitude of the estimates. For example, a statistical significant unexplainable negative relationship between the endogenous variable and a potential instrument makes the instrument questionable (Wooldridge, 2013 p. 516).

It is difficult to test instrument exogeneity (equation 5.3) (Wooldridge, 2013 p.514). However, like Angrist and Evans (1998), I will check this by comparing the demographic of women whose first two children are of the same gender and those with mixed gender. If the instrument fulfils this property, then there should be no significant differences in the demographic characteristics between these two groups of women.

If the instrument is a good instrument, then the predicted value of fertility (*more than two children*) which was obtained in the first stage by using only those exogenous variables can be used in the second stage to come up with an estimate of fertility which is independent of the error term.The regression linking fertility (having a third child) to FLFP is

$$Y_i = \alpha_0 D_i + \beta_{2SLS} X_i + U_i \quad (5.16)$$

Where Y_i measures the labour force participation of mother i, X_i is the predicted value of fertility from the regression of fertility on the instrument obtained in stage 1 and $ß_{2SLS}$ is the 2SLS estimator.

6. Results[46]

6.1. Instrument Exogeneity

Following Aguero and Marks (2008), to check if the instrument of gender composition of a woman's first two children fulfils the exogeneity requirement for a good instrument, I compare the demographic characteristics of women whose first two children are of mixed gender with those with the same gender. Table 1 shows the differences in mean characteristics between women whose first two children are of mixed gender and those whose first two children are of the same gender. The absence of differences in the demographic characteristics between women whose first two children are of the same and those whose first two children are of mixed gender indicates that there is no correlation between the instrument and the error term (Aguero and Marks 2008; Angrist and Evans 1998).

[46] See Appendix A for the Stata codes used for analysis

Table1

Differences in mean characteristics by gender composition of first two children

Variables	All years	1976	1987	2005
Number of children	0.003	-0.022*	-0.027**	0.0998
	(0.0080)	(0.0143)	(0.1171)	(0.0169)
Less than primary completed	-0.001	-0.005*	-0.0107***	0.0008
	(0.0025)	(0.0034)	(0.0039)	(0.0053)
Primary completed	0.002	0.004	0.011	-0.001
	(0.0025)	(0.0034)	(0.0038)	(0.0054)
Secondary completed	-0.0009	0.0006	-0.0007	0.0001
	(0.0007)	(0.0006)	(0.0008)	(0.0025)
University completed	-0.0009	0.0006	-0.0007	0.0001
	(0.0007)	(0.0006)	(0.0008)	(0.0025)
Age	0.078	-0.031	-0.069**	0.499
	(0.0261)	(0.0462)	(0.0389)	(0.0538)
Married	0.004	-0.0001	-0.00001	0.012
	(0.0015)	(0.0022)	(0.0020)	(0.0038)
Employed	0.007	0.001	0.003	0.010
	(0.0026)	(0.0047)	(0.0040)	(0.0051)
Observations	140359	44670	61374	34315

The sample includes mothers aged 15 to 35 with at least two children. Mean characteristic difference = mean (women whose first children are of mixed gender) minus mean (women whose first two children are of the same gender).Standard errors in parentheses. *** 1% significance level, **5% significance level, * 10% significance level. Data are unweighted.

The table shows that for the 1976 and 1987 data, the mean number of children women whose first two children are of the same gender have is statistically significantly slightly more than those had by mothers whose first two children are of different genders. Except for the variable less than primary school and age in the 1987 sample, there is no statistically significant difference in demographic between mothers whose first two children are of the same gender and those whose first two children are not of the same gender. Hence there is little evidence that the gender composition of a woman´s first two children violates the instrument exogeneity property.

6.2. Instrument Relevance

To test whether there is a correlation between fertility and the gender of the first two children, I estimate equations 5.13, 5.14 and 5.15 separately. Fertility which is the dependent variable here is expressed as having more than two children. Table 2 presents the results of the logistic regressions. I estimate two models. Model 1 has no control variables, whereas model 2 includes exogenous control variables. The coefficient reported are the marginal effects. Table 2 show that in the 2005 data (model 2) compared to women whose first two children are of mixed gender, mothers whose first two are of the same gender are 3.8% less likely to have a third child. The result also indicates a bias for girls, that is, women whose first two children were girls were less likely to have a third child than those whose first two children were boys. However, for the 1976 and 1987 data, the coefficient are almost always insignificant. Although for the combined samples and when disaggregated by year, the first stage regression yield some significant results, the negative relationship between having same gender children and having more than two children cannot be justified. In addition the strength of the correlation between the instrumental variable (gender of the first two children) and the endogenous variable (more than two children) is very small (the partial R^2 value of the instrument same gender, two boys and two girls is 0.0019 or for both the pooled and the disaggregated sample, see Table 2)[47], so it is not a suitable instrument for fertility in Cameroon. Bound, Jaeger and Baker (1995 p. 445) point out that "in a finite sample, instrumental variable estimates are biased in the direction of the OLS estimator" and when an instrument is weakly correlated with the endogenous variable, a small correlation between the instrument and the error term is amplified, and the result is even larger biases. In addition the F-statistic of the instrument is less than 10, the minimum value for a strong instrument (Stock et al 2002). Table 3 presents the results of the ordinary least square estimates of having more than two children on the gender composition of the first two children. The results are similar to those obtained by logit regression.

[47]The partial R^2 is the strength of the relationship between the instrument and the endogenous variable when the effect of the other exogenous variables have been partialled out (Bound, et al., 1995 p. 444)

Table 2
Binomial logit regressions of the presence of more than two children

	Model 1	Model 2			
Instrument	All years	All years	1976	1987	2005
Same gender	-0.012***	-0.009***	-0.003	0.003	-0.038***
	(0.003)	(0.002)	(0.004)	(0.004)	(0.005)
Partial R^2	0.0001	0.0001	0.0000	0.0000	0.0019
F-statistic	4.342	4.341	1.811	1.863	1.991
Two boys	0.005	0.001	0.008	0.007*	-0.016***
	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)
Partial R^2	0.0000	0.0000	0.0000	0.0000	0.0003
F-statistic	5.333	5.232	2.111	2.078	1.991
Twogirls	-0.021***	-0.014***	-0.013**	-0.004	-0.032***
	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)
Partial R^2	0.0003	0.0002	0.0001	0.0000	0.0011
F-statistic	5.781	5.782	2.111	2.081	2.001
Observations	140359	140359	44670	61374	34315

The sample includes mothers aged 15 to 35 with at least two children. Data are unweighted. Model 1 does not include covariates. Model 2 includes control variables for age, education, geographical area and marital status. Robust standard errors in parentheses. *** 1% significance level, ** 5% significance level, * 10% significance level. The *same gender* instrument indicates that the first two children are of the same gender, *Two boys* indicates that the first two children are boys, and *Two girls* indicate that the first two children are girls. Data are unweighted.

Table 3
OLS regressions of the presence of more than two children

	Model 1	Model 2			
Instrument	All years	All years	1976	1987	2005
Same gender	-0.012***	-0.009***	-0.003	0.003	-0.040***
	(0.003)	(0.002)	(0.004)	(0.004)	(0.005)
Two boys	0.005	0.001	0.008*	0.007*	-0.018***
	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)
Twogirls	-0.021***	-0.014***	-0.013***	-0.004	-0.033***
	(0.003)	(0.003)	(0.005)	(0.004)	(0.006)
Observations	140359	140359	44670	61374	34315

The sample includes mothers aged 15 to 35 with at least two children. Data are unweighted. Model 1 does not include covariates. Model 2 includes control variables for age, education, geographical area and marital status. Robust standard errors in parentheses. ***1% significance level, ** 5% significance level, * 10% significance level. The *same gender*

instrument indicates that the first two children are of the same gender, *Two boys* indicates that the first two children are boys, and *Two girls* indicate that the first two children are girls. Data are unweighted.

6.3. Two-Stage Least-Squares and Ordinary Least Squares Estimation

In this subsection, I present results obtained by estimating equation 1 by two-stage least squares (2SLS) regression using gender composition as an instrument for fertility. Even though the instrument and the dependent variable are binary variables, I still use the 2SLS approach that is based on linear probability models, as it has been shown by Angrist (2001) to be suitable for use in this context.[48] I also present the results using OLS regression. The dependent variable in these regressions is employed, which takes the value 1 if a woman is employed or 0, otherwise. The OLS result shows that having more than two children negatively affects a woman's labour force participation. Although the effect is statistically significant, the magnitude is small. The estimate lies between a 95% confidence interval that ranges from -2.1% to -0.98%. When disaggregated by years, the OLS estimate is insignificant for the year 2005. The instrumental variable estimates are considerably larger than the OLS estimates. The estimate for all the years with *same gender* instrument is positive and significant. The estimate lies between a 95% confidence interval that ranges from -6% to 120%. As expected, the standard errors of the 2SLS estimates are much greater than those of the OLS estimates due to the weak correlation between the instrument and the endogenous variable (Wooldridge, 2003).

[48]Angrist and Pischke (2009 p.151) also suggest that estimates produced by bivariate probit model (which takes into account the binary nature of the dependent and the instrumental variable) are typically similar to 2SLS estimates.

Table 4
OLS and 2SLS estimates of the impact an additional child on female labour force participation

	Instrument	All years	1976	1987	2005
OLS		-0.0155***	-0.0152***	-0.0120***	0.00104
		(0.00288)	(0.00511)	(0.00437)	(0.00570)
2SLS	**Same gender**	0.574*	0.833	-2.043	0.151
		(0.324)	(2.300)	(3.153)	(0.131)
	Two boys	-18.20	-2.086	-1.829	0.658
		(71.40)	(1.591)	(1.458)	(0.407)
	Two girls	-0.497**	-1.185*	-1.549	-0.113
		(0.251)	(0.702)	(2.853)	(0.173)

The sample includes mothers aged 15 to 35 with at least two children. The *same gender* instrument indicates that the first two children are of the same gender, *Two boys* indicates that the first two children are boys, and *Two girls* indicate that the first two children are girls. Control variables for age, education, geographical area and marital status are also included in the regressions. Data are unweighted. Robust standard errors in parentheses. *** 1% significance level, ** 5% significance level, * 10% significance level.

7. Conclusion

Instrumental variable estimations can be used to address the problem of endogenous regressors. The key to obtaining consistent and unbiased estimates is using instruments that are uncorrelated with the error term but significantly and strongly correlated with the endogenous regressors. Several studies (see for example Angrist and Evans, 1998; Cruces and Galiani, 2007) have found the gender composition of a woman´s first two children to be a good instrument for fertility (having another child). This study seeks to investigate if this is the case for Cameroon. I find that although this instrument satisfies the instrument exogeneity condition, it violates the property of relevance. This is consistent with what Van der Stoep, (2009) found using South African data. Therefore using the gender composition of the first two children of a woman as an instrument of fertility in Cameroon produces estimates with large standard errors (Bound et al., 1995). This may be due to the fact that women in Cameroon have more children and so there are less concern about the gender of their first two children.

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Appendix A

```
/* Attaching the age and gender of children to their moms*/
keep if momloc > 0
keep year serial momloc age sex
/* Renaming MOMLOC pernum we give it the pernum of a child´s mom*/
rename momloc pernum
```

```
rename age age_child
rename sex gender_child
sort year serial pernum
save temp.dta,replace
use "\\CL02-SFH-SERVER\SFH\sf\home\agborndip\Konfig32\Desktop\Phd\Female labour supply\Data analysis\IPUMSI original data.dta", clear
isid year serial pernum
merge 1:m year serial pernum using temp.dta
sort year serial pernum
/* investigating unmatched data*/
drop _merge

//*Cleaning data*//

/* keep moms with two or more children*/
keep if sex == 2 & nchild > 1
sort year serial pernum

/* keep moms 15 to 35*/
drop if age < 15 | age > 35
sort year serial pernum

/* Construct the gender of the first two children*/
 * if the first child is a boy:
gen boy_first=0
bysort year serial pernum (age_child): replace boy_first= 1 if gender_child[_N]==1

*if the first child is a girl:
gen girl_first=0
bysort year serial pernum (age_child): replace girl_first = 1 if gender_child[_N]==2

* If the 2nd child is a boy:
gen boy_second=0
bysort year serial pernum (age_child): replace boy_second= 1 if gender_child[_N-1]==1

* If the 2nd child is a girl:
gen girl_second=0
bysort year serial pernum (age_child): replace girl_second = 1 if gender_child[_N-1]==2

*If the first two children are of the same gender:
gen same_sex=0
bysort year serial pernum (age_child): replace same_sex = 1 if gender_child[_N]==gender_child[_N-1]

*If the first two children are of mixed sex:
gen mixed_sex =0
replace mixed_sex = 1 if same_sex ==0
```

```
*If the first two children are boys:
gen two_boys =0
replace two_boys = 1 if boy_first & boy_second==1

*If the first two children are girls:
gen two_girls =0
replace two_girls = 1 if girl_first & girl_second==1

/* cleaning the variables*/
* Dealing with  Education attained varaible:
summarize bn. classwk
replace edattain =. if edattain == 0 // not in universe
replace edattain =. if edattain == 9 // Unknown

gen less than primary = 0
replace less than primary = 1 if edattain ==1
gen primary = 0
replace primary = 1 if edattain ==2
gen secondary= 0
replace secondary = 1 if edattain ==3
gen university = 0
replace university = 1 if edattain ==3


//* Dealing with  year*//
gen yearvar = 0
replace yearvar = 1 if year == 1976
replace yearvar = 2 if year == 1987
replace yearvar = 3 if year == 2005

* Dealing with marital status varaible:
replace marst =. if marst == 0 // not in universe
replace marst =. if marst == 9 // Unknown

* Dealing with age varaible:
replace age =. if age == 999 // not reported or missing


/* creating new variable equal to 1 if mom is employed*/
* Dealing with age varaible:
replace age =. if empstat == 9 // not reported or missing
gen employed =0
replace employed = 1 if empstat ==1

/* new variable equal 1 if a mom has more than 2 children*/
gen morethan2children =0
replace morethan2children = 1 if nchild > 2
```

```
/* new variable equal 1 if a mom his married or in a union*/
gen married =0
replace married = 1 if marst == 2


* Creating variable for moms whose first two children are of the same gender and went ahead and had a third:
gen samesexthird = 0
replace samesexthird = 1 if same_sex & morethan2children==1

* Creating variable for moms whose first two children are of the different gender and went ahead and had a third:
gen mixedsexthird = 0
replace mixedsexthird = 1 if mixed_sex & morethan2children==1

* Creating variable for moms whose first two children are girls and went ahead and had a third:
gen twogirlsthird = 0
replace twogirlsthird = 1 if two_girls & morethan2children==1

* Creating variable for moms whose first two children are boys and went ahead and had a third:
gen twoboysthird = 0
replace twoboysthird = 1 if two_boys & morethan2children==1


/* descriptive statistics for moms aged 15 to 35 with two or more children*/
/* Since each mother appear once for each child this tags each mother only once for analysis*//
egen byte mom_once = tag(year serial pernum)

/* Dropping all but one duplicates of mom*/
* only keeping one row per mom:
keep if mom_once==1

 //*dealing with missing data*//
drop school
missings report
drop if missing(age)
drop if missing(marst)
drop if missing(edattain)


//* comparing proportion of women with mixed and same gender*//
by year: ttest nchild, by (same_sex)
by year: ttest primary, by (same_sex)
by year: ttest less than primary, by (same_sex)
by year: ttest secondary, by (same_sex)
```

```
by year: ttest university , by (same_sex)
by year: ttest age, by (same_sex)
by year: ttest married, by (same_sex)
by year: ttest employed, by (same_sex)
///* all yearscomparing proportion of women with mixed and same gender*//
ttest nchild, by (same_sex)
ttest primary, by (same_sex)
ttest less than primary, by (same_sex)
ttest secondary, by (same_sex)
ttest university, by (same_sex)
ttest age, by (same_sex)
ttest married, by (same_sex)
ttest employed, by (same_sex)

/*Logit regression of same gender  on covariates*/

logit same_sex age i.married i.edattain i.geo1_cm if year ==1976 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
logit same_sex age i.married i.edattain i.geo1_cm if year ==1987 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit same_sex age i.married i.edattain i.geo1_cm if year ==2005 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit same_sex age i.married i.edattain i.geo1_cm,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)

//*ols regression of same gender  on covariates*//
regress same_sex age i.married i.edattain i.geo1_cm if year ==1976 ,vce(robust)
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
regress same_sex age i.married i.edattain i.geo1_cm if year ==1987 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress same_sex age i.married i.edattain i.geo1_cm if year ==2005 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress same_sex age i.married i.edattain i.geo1_cm,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)


/*Logit regression more than two children on same gender*/

logit morethan2children age i.married i.edattain i.employed i.geo1_cm same_sex if year
==1976 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm same_sex if year
==1987 ,vce(robust)
```

```
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm same_sex if year ==2005 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)


/*Logit regression more than two children on two boys*/

logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_boys if year ==1976 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_boys if year ==1987 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_boys if year ==2005 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)


/*Logit regression more than two children on two girls*/

logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==1976 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==1987 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==2005 ,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)




//* two girls*//
logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==1976 ,vce(robust)
predict yhat if e(sample)
ttest yhat, by(morethan2children)
```

```
logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==1987 ,vce(robust)
predict yhat if e(sample)
ttest yhat, by(morethan2children)

logit morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==2005 ,vce(robust)
predict yhat if e(sample)
ttest yhat, by(morethan2children)

/*OLS regression more than two children on same gender*/

regress morethan2children age i.married i.edattain i.employed i.geo1_cm same_sex if year ==1976 ,vce(robust)
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm same_sex if year ==1987 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm same_sex if year ==2005 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)


/*OLS regression more than two children on two boys*/

regress morethan2children age i.married i.edattain i.employed i.geo1_cm two_boys if year ==1976 ,vce(robust)
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm two_boys if year ==1987 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm two_boys if year ==2005 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)


/*OLS regression more than two children on two girls*/

regress morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==1976 ,vce(robust)
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==1987 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm two_girls if year ==2005 ,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
```

```
/*OLS regression allyears*/
regress morethan2children age i.married i.edattain i.employed i.geo1_cm yearvar same_sex,vce(robust)
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm yearvar two_boys,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress morethan2children age i.married i.edattain i.employed i.geo1_cm yearvar two_girls,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)

/*OLS regression allyears with no covariates*/
regress morethan2children same_sex,vce(robust)
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
regress morethan2children two_boys,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
regress morethan2children two_girls,vce(robust)
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)


/*logit regression allyears*/
logit morethan2children age i.married i.edattain i.employed i.geo1_cm yearvar same_sex,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm yearvar two_boys,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit morethan2children age i.married i.edattain i.employed i.geo1_cm yearvar two_girls,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)

*logit regression allyears with no covariate. wald estimator*/
logit morethan2children same_sex,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, replace dec (3) pdec(4)
logit morethan2children two_boys,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)
logit morethan2children two_girls,vce(robust)
margins, dydx(*) post
outreg2 using E:\logisticregression.doc, append dec (3) pdec(4)

/*OLS regression employed on  morethan2children as the measure for fertility and outreg2 to make publication style tables*/
regress employed morethan2children age married edattain geo1_cm yearvar, vce (robust)
```

```
outreg2 using E:\olsregression.doc, replace ctitle (2005)
regress employed morethan2children age married edattain geo1_cm if year ==1976, vce (robust)
outreg2 using E:\olsregression.doc, append ctitle (1976)
regress employed morethan2children age married edattain geo1_cm  if year ==1987, vce (robust)
outreg2 using E:\olsregression.doc, append ctitle (1987)
regress employed morethan2children age married edattain geo1_cm  if year ==2005, vce (robust)
outreg2 using E:\olsregression.doc, append ctitle (2005)


/*2 stage least square same sex*//
ivreg2 employed age (morethan2children = same_sex) married edattain geo1_cm, ffirst
outreg2 using E:\olsregression.doc, replace ctitle (1976)
ivregress 2sls employed age married edattain geo1_cm (morethan2children = same_sex) if year ==1987,vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (1987)
ivregress 2sls employed age married edattain geo1_cm (morethan2children = same_sex) if year ==2005,vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (2005)
ivregress 2sls employed age married edattain geo1_cm yearvar (morethan2children = same_sex),vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (all)

//*2 stage least square two boys*//
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_boys) if year ==1976 ,vce(robust)
outreg2 using E:\olsregression.doc, replace ctitle (1976)
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_boys) if year ==1987,vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (1987)
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_boys) if year ==2005,vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (2005)
ivregress 2sls employed age married edattain geo1_cm yearvar (morethan2children = two_boys),vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (2005)


//*2 stage least square two girls*//
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_girls) if year ==1976 ,vce(robust)
outreg2 using E:\olsregression.doc, replace ctitle (1976)
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_girls) if year ==1987,vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (1987)
```

```
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_girls) if year ==2005,vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (2005)
ivregress 2sls employed age married edattain geo1_cm yearvar (morethan2children = two_girls),vce(robust)
outreg2 using E:\olsregression.doc, append ctitle (2005)


//* instrument validity*//

ivregress 2sls employed age married edattain geo1_cm (morethan2children = same_sex) if year ==1976,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm (morethan2children = same_sex) if year ==1987,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm (morethan2children = same_sex) if year ==2005,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm yearvar (morethan2children = same_sex),vce(robust)
estat firststage
ivregress 2sls employed (morethan2children = same_sex),vce(robust)
estat firststage

//*2 stage least square two boys*//
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_boys) if year ==1976 ,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_boys) if year ==1987,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_boys) if year ==2005,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm yearvar (morethan2children = two_boys),vce(robust)
estat firststage
ivregress 2sls employed (morethan2children = two_boys),vce(robust)
estat firststage


//*2 stage least square two girls*//
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_girls) if year ==1976 ,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_girls) if year ==1987,vce(robust)
```

```
estat firststage
ivregress 2sls employed age married edattain geo1_cm (morethan2children = two_girls) if year ==2005,vce(robust)
estat firststage
ivregress 2sls employed age married edattain geo1_cm yearvar (morethan2children = two_girls),vce(robust)
estat firststage
ivregress 2sls employed (morethan2children = two_girls),vce(robust)
estat firststage
```

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01/2007- 01/2010	Bachelor of Science (Mathematics), Roosevelt Academy, University of Utrecht, The Netherlands.
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Conference presentations

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SIBR 2017 Sydney conference on Interdisciplinary Business & Economic Research